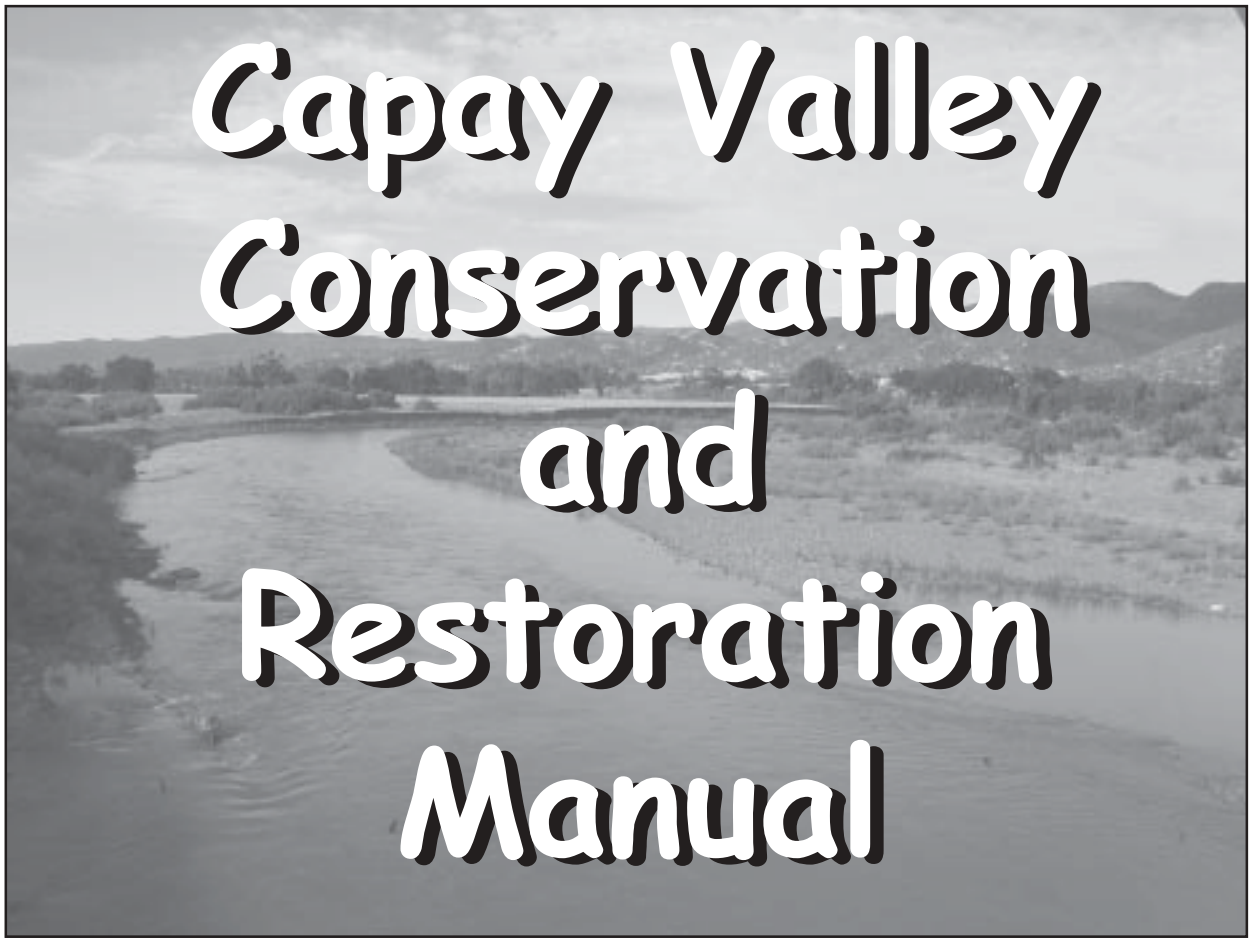

Capay Valley Conservation and Restoration Manual

A Handbook for Landowners

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Capay Valley Conservation and Restoration Manual

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For the Cache Creek Watershed Stakeholders Group
Thank you for your patience, guidance, and support.

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Introduction

Purpose Of This Manual

Do you find yourself constantly battling unwanted weeds on your land? Are you tired of watching the stream erode and send your land downstream? Don't know what to do about that gully that just gets larger every year? *The Capay Valley Conservation and Restoration Manual* provides over 30 potential solutions to these and many other resource concerns in Capay Valley.

This manual is the culmination of several years of hard work by the Cache Creek Watershed Stakeholders Group, the Yolo County Resource Conservation District, and the USDA Natural Resources Conservation Service's Woodland Field Office. Its purpose is to provide techniques to support solutions for many of the resource concerns (e.g. erosion, invasive plants) experienced in the Capay Valley. Techniques range from weed control to habitat and sediment ponds to streambank stabilization.

In the manual, techniques are referred to as 'practices'. Take note that these practices, by themselves, are not the solutions to the resource problems. Only after thorough research and careful planning should these practices be employed. Think of each practice as a tool in your new conservation and restoration toolbox. You need to know what you are doing and why you are doing it before you take the tool out of the toolbox. First, identify the symptom. Second, figure out the source of the symptom (i.e. the problem). Third, plan how to address the problem. Finally, choose the "tool" or "tools" that best fix the problem. Remember; don't treat the symptom without first addressing the problem. This will save you time, money, and effort.

The manual has been created in a format that is easy to use, update, and share. The essential techniques for each practice have been condensed and refined so as to fit on one page, front and back. The information contained on the practice pages is intended to be succinct, yet informative enough to be useful. If you find that you are not comfortable with taking on a project based on the practice pages, simply refer to one of the reference documents listed at the bottom of the front page of each practice. Most of the reference documents are available in the special watershed section at the Esparto Library.

Finally, think of the manual as a 'working document'. It is made to be put to use. It is also designed to be relevant and useful to the Capay Valley community. The manual is purposely not bound so that pages can be added as the community identifies new needs and seeks out new solutions to resource concerns. Suggestions, comments, and additions should be directed to the Stakeholders Group and the Watershed Coordinator.

How to UseThis Manual

The manual does not need to be read from cover to cover to be useful. The introductory sections on the *Cultural and Natural History of Capay Valley, Basic Watershed Processes,* and *Permits and Regulations* provide useful information how watershed function, some of the unique features of Capay Valley, and the laws and regulations that may be affected by potential work. Knowledge of watershed function and form can aid in understanding the processes affecting your property.

With that information you can identify the causes of a problem on your property and decide what needs to be done to rectify it. The *Resource Concern-Possible Solutions List* provides a means for choosing the appropriate tool for the situation. If your resource concern is not listed, refer directly to the practices. The practices are divided into three categories based on topography and land use: Upland and Rangeland Practices, Lowland and Agricultural Land Practices, and Riparian Practices. These are not mutually exclusive categories. A list of the practices can be found on page 18.

First, search the list under the category most similar to the topography and land use where the resource concern exists. The appropriate practice may be obvious from the title, or you may need to read about each practice to find one that fits your project's needs. Each practice contains five sections. On the front page you will find a description of the practice (section 1) and a description of the conditions or situations where the practice can be effectively implemented (section 2). The third section lists the materials and equipment required to implement the project. The last section on the frontside of each practice page is a list of the documents referenced in writing the practice. The backside of each practice page is dedicated to describing how to implement the practice.

Additional useful information can be found at the end of the manual. These resources include plant lists, a listing of local nurseries and erosion control products and irrigation system suppliers, contacts for technical assistance, a description of USDA-NRCS and other cost share programs, a partial list of grant programs, a glossary of terms used in the manual, and a list of useful reference materials.

Capay Valley

Physical Setting

The Capay Valley of today is a small valley hosting productive agriculture in its fertile bottomlands, and range and wildlands on the slopes bordering its eastern and western flanks. A defining characteristic is the presence of Cache Creek, which runs generally southward along the valley's eastern edge. The creek drains the mountains from the northwest, hosting wildlife, delivering water to the valley, and alternately eroding and depositing sediments and gravel along its banks. The valley is unique in that it has never been heavily populated nor supported large agricultural parcels, giving it a quiet, rural quality that has lasted through the 20th century. This placid atmosphere belies the dynamic geology, which has determined its form, vegetation, and land uses.

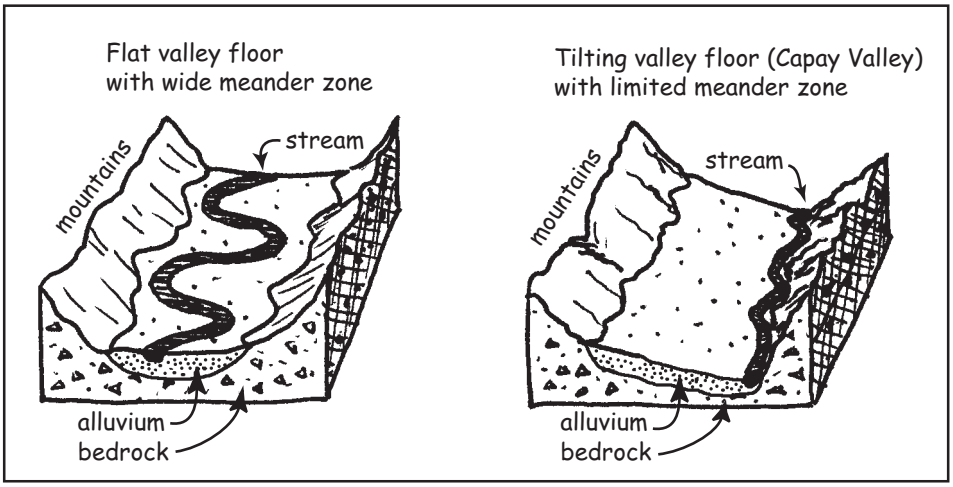
Capay Valley Geology

The valley floor consists of deep, alluvial soils deposited by Cache Creek and its tributaries. These deposits make up the deep, rich soils that host the productive agriculture of Capay Valley and the Great Central Valley. The western walls of the valley are Cretaceous rocks (formed 145-65 million years ago) of the so-called Great Valley Group that were deposited when the Central Valley was an inland sea. As with the rest of the region, the area now known as Capay Valley was under water for millennia.

The eastern wall of Capay Valley consists of two different ages and types of rocks. The lower slopes are younger, formed in the Pleistocene era 2 million to 10 thousand years ago. The upper 1/4 of the eastern wall of the Valley consists of older Cretaceous Great Valley Group rocks (the same as the rocks on the opposite side of the valley). At the interface on the slope there is a change in pitch caused by the thrust fault which has superimposed the older rocks over the much younger Pleistocene rocks exposed at river level.

Due to active tectonics, the floor of Capay Valley is increasingly tipping downward to the east. As a result, Cache Creek is confined mostly to the eastern side of the valley (see Figure). This differs from most meandering streams, which can meander across the entire valley floor. Because of the tectonically-induced confinement of the stream, the effective "floodplain" is much narrower than the whole valley floor. This unique situation impacts Valley land uses. Whereas, on a level valley floor, the water table may be at a fairly uniform depth below the surface, the inclined valley floor affects the water table accordingly.

The way in which the stream erodes land and deposits sediment is also affected by the tectonic situation. An idealized single-channel stream would be free to meander across the entire valley floor (where valley floor = floodplain). Since the Capay Valley floor is being tipped eastward, the stream's ability to traverse the entire valley floor is severely limited. Erosion-resistant Pleistocene (Ice Age) rock is exposed on the eastern side, forcing Cache Creek to focus its erosive activity on the western banks, which are composed of the much more easily eroded alluvium (older river deposits). The effects of the 1997 New Year's Flood made this point clear: while the stream did not significantly erode the eastern bedrock banks, approximately 30 acres of alluvium on the western bank where eroded at Guinda Park.



Capay Valley

Physical Setting and Cultural History

Vegetation

The historic landscape of Capay Valley is much like that of the rest of the Great Central Valley, with dense riparian forests dominating the stream corridor of Cache Creek, giving way to grasslands and oak woodlands on the valley floor and uplands. These uplands have been affected most dramatically by agriculture, as native trees, shrubs and grasses were removed to provide home for food crops and improved forage. While the area of the old riparian forests has been reduced to accommodate agricultural and, to a lesser extent, urban development, significant stretches of native riparian forest remain along portions of Cache Creek. Introduced exotic "erosion control" plants such as Tamarisk and Giant reed also play an increasing role in the streamside (and mid-channel bar) vegetation, displacing native trees and shrubs more valuable to wildlife, and exacerbating bank erosion by diverting stream flows. The foothill and mountainous areas flanking Capay Valley have the most intact native plant communities, although some historical impact of human activity and livestock management is evident in the dominance of non-native, annual or improved grass and forb species in the understory. While most of these relatively new plant species provide excellent forage for wildlife and livestock, there are also increasing concentrations of noxious weedy species such as Yellow starthistle, Barbed goatgrass, and Medusahead that threaten to reduce the quality of Capay Valley rangelands.

Human settlement and changes

Human activity in Capay Valley extends far into prehistory. Native American tribes lived in camps along Cache Creek for centuries, hunting and fishing for their livelihoods. In the early 19th century European and American explorers and trappers began to move through the southern Sacramento Valley, bringing with them diseases that took a heavy toll on the native people. Some of the Southern Wintun Indian tribe continued to live in the upper reaches of the Capay Valley, however, even after Mexican land grants appropriated most of the territory. After the turn of the Century, the remaining band of local Wintun Indians was relocated from its old village site northeast of Rumsey to a federally purchased rancheria on the other side of the valley; later (1942) some of the band moved to a new site near Brooks (which now hosts the Cache Creek Casino), while others moved to Colusa County.

Significant changes to the landscape did not likely begin until European settlement and activity in Capay Valley began in the 1840s with the Guesissosi and Rancho Canada de Capay grants. At that time, cattle grazing was the area's principal economic activity. Land speculation, subdivision of parcels, and planting of grain, grapevines, and fruit trees began in the 1860's. Also at that time, scattered ranches and tiny settlements developed along the primitive road leading to the quicksilver (mercury) mines in the canyon country to the west. By the 1870s several small schools were established in the Capay Valley and by 1890, a railroad line extended from Winters to Rumsey for passenger and agricultural freight traffic. By 1900, the population of the Capay Valley was numbered over 1,300. In 2002 around 4,000 people live in the valley.

Dominant crops shifted over the years from fruit orchards, to almonds, and, more recently, to walnuts as markets changed and growing conditions required. Agricultural development was fueled in no small part by water development projects such as the Rumsey Ditch Association's eight-mile irrigation canal from Cache Creek above Rumsey to north of Guinda , the Yolo Water and Power Company's dam across the outlet of Clear Lake that feeds into Cache Creek (1914), and the Indian Valley Dam in 1975. During the1980s, a new trend in valley agriculture began as organic growers began intensive farming in the area, gradually building markets and expanding their acreage in a variety of crops. By 1995 the valley's organic agriculture brought in nearly a million dollars in revenues, as reported by the county Agricultural Commissioner, and the figure grew to more than $3 million in 2001.

While the long-standing Wintun presence in the Valley may have influenced some of the vegetation of the Valley through traditional grassland management techniques such as burning, the radical changes associated with the advent of mining, intensive agriculture and the creation of towns compelled community members to identify local concerns and attempt to codify and maintain the unique, rural characteristics of Capay Valley. Such efforts include the development of the Capay Valley Community Area Plan in 1983, the formation of the Cache Creek Watershed Stakeholders Group in 1996, and the formation of the Capay Valley Visioning process initiated in 2000.

Watershed issues identified by the Stakeholders Group include flooding, erosion, noxious weeds, mercury in the creek, and wildlife habitat. While the dams upstream on Cache Creek have improved flood protection, some flooding and streambank erosion problems are still a part of life in the Valley, especially during wet years.

Watershed Stewardship

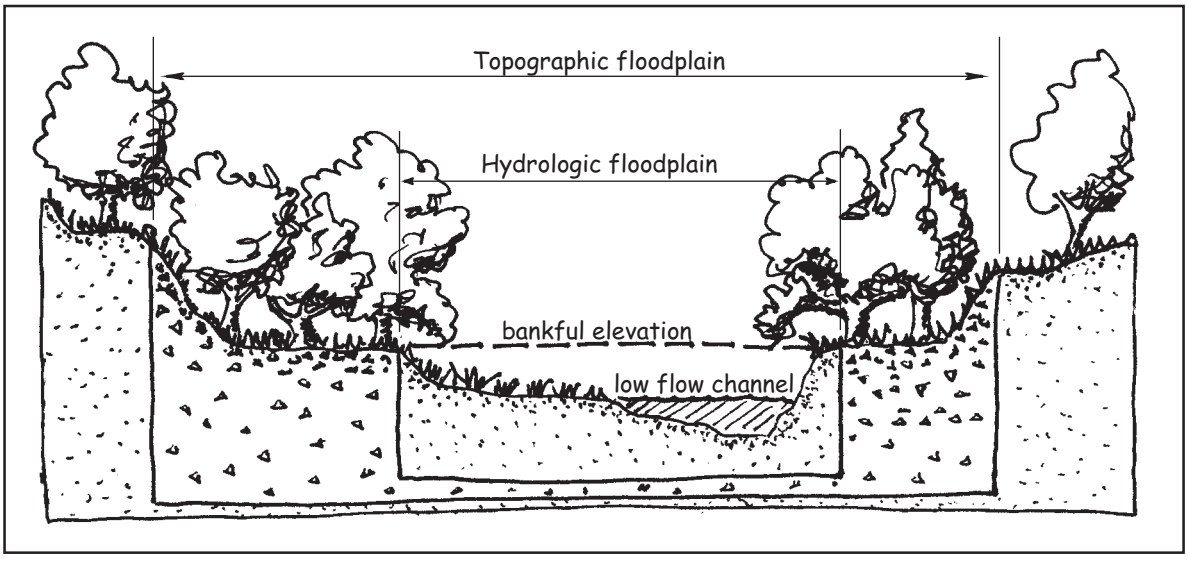
Basic Watershed Processes*

The purpose of this section is to give you a glimpse at the processes responsible for stream shape and function and to introduce you to some terms that will be used throughout this manual. A watershed is defined as an area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel (Dunne, T. and Leopold, L.B., 1978). It may help you to think of watersheds as drainage basins. Watersheds occur at multiple scales, from small swales that may drain only an acre to large river systems that drain thousands of square miles. The smaller drainages are often referred to as sub-watersheds. Several sub-watersheds combine to form a larger watershed. Watershed boundaries are drawn along the ridgelines that surround the waterway of interest.

Since the watershed is based on the movement of water, it is important to review the means by which water can move through a system. Precipitation falls to the surface of the earth either as rain or snow. Some of the precipitation is intercepted and absorbed by vegetation before it reaches the soil surface. The precipitation that does reach the soil surface infiltrates into the soil by means of gravity and capillary action. Water will continue to move down through the soil until it reaches a zone of saturation known as the phreatic zone. The top of the phreatic zone defines the ground water table. The area above the phreatic zone is called the capillary fringe, where soil moisture is maintained by capillary forces. Between the capillary fringe and the soil surface is the vadose zone. The vadose zone is where plant roots thrive because the pore spaces between the soil particles contain a mixture of respiratory gases, capillary water, and soil microbes. When the rate of precipitation exceeds the infiltration capacity of the soil, excess water collects on the surface and flows downslope as runoff. Runoff may also occur just below the soil surface as subsurface flow.

A major component of the watershed is the stream corridor. The stream corridor can be thought of both temporally and spatially. The processes that formed a stream corridor are observed as many small events occurring over short amounts of time, while it is the accumulation of the effects of these events over millions of years that creates the stream corridor observed today. Spatially, the stream corridor can be considered in two dimensions: 1. lateral and 2. longitudinal.

1. Lateral components of the stream corridor include the stream channel, floodplain, and the transitional upland fringe. The stream channel is a channel that exhibits flowing water at least part of the year. The floodplain is the area adjacent to the stream channel that is occasionally flooded during high flows. The transitional upland fringe is the area that serves as the border between the floodplain and the surrounding landscape. While stream related processes helped form the transitional upland fringe in geologic times, their current form is maintained or altered to a greater extent by recent land use activities. Therefore, the following will consider the physical processes of formation and the function of the stream channel and the floodplain.



Watershed Stewardship

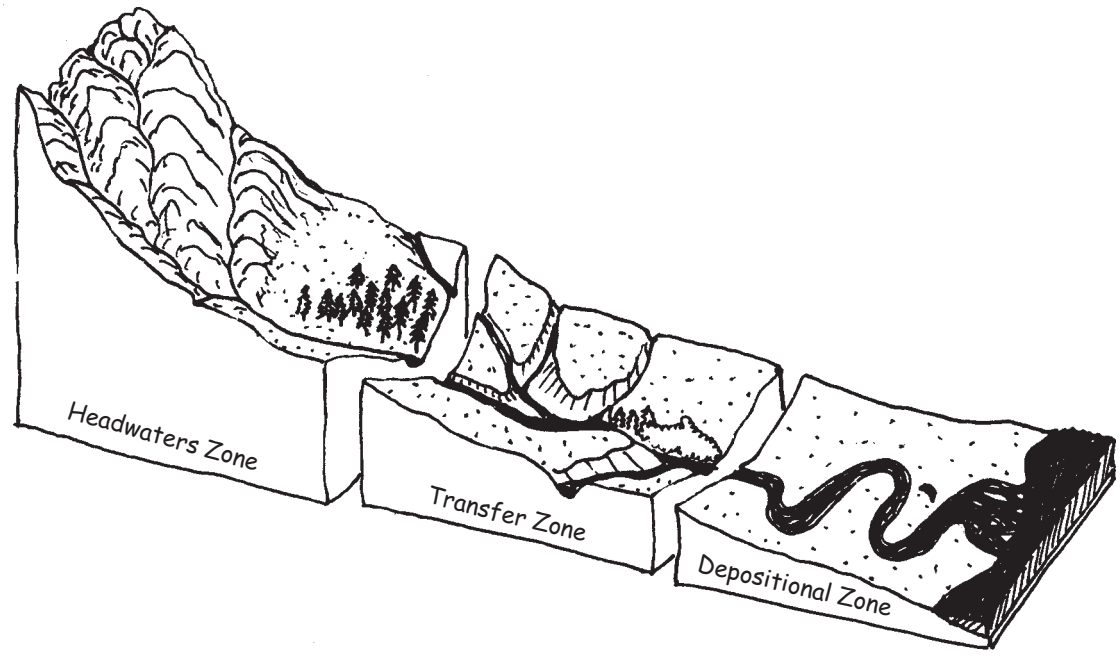
Basic Watershed Processes* continued

Stream channels are formed, maintained, and altered by the water and sediment they carry. A typical cross section of a stream channel (see Figure on previous page) shows the thalweg – the deepest part of the channel, the baseflow channel – the channel created by low flows, and the scarp – the sloped streambank. The size and shape of the channel are determined by four basic factors: Sediment discharge (Q_s) – the amount of sediment moving down the stream at a given time; Sediment particle size (D_{50}); Streamflow (Q_w) – the volume of water moving down the stream at a given time (also called discharge); and Stream slope (S) – the elevation drop between an upstream point and a downstream point. Channel equilibrium occurs when all four variables are in balance. The nature of the relationship is that if one of the variables changes, one or more of the other variables must increase or decrease proportionally in order to maintain equilibrium. For example, if streamflow is increased and the slope remains the same, sediment load or particle size must increase.

The stream channel is constantly changing to maintain this equilibrium. When the stream channel is out of balance the changes can be visually recognized in the form of degradation or aggradation. Degradation is the downcutting of the stream channel. Aggradation is the deposition of sediment and suspended bed material in the stream channel. In alluvial stream systems sediment and bed material is typically scoured from the outer bends of the stream and deposited as sand or gravel bars in the straight sections and on the inside of the bends. The size of the material that is scoured and where it deposits is dependent on many factors including streamflow (or discharge), gradient, channel area, and velocity. For example, if a bar is made up of large cobbles, it is safe to assume that a large streamflow event with high velocities was responsible for depositing the cobbles and it will take a similar event to mobilize the cobbles again.

There are two types of floodplains: Hydrologic and Topographic. The hydrologic floodplain is the area up to the top of the bank of the stream channel that becomes inundated when the streamflow exceeds the capacity of the baseflow channel. The topographic floodplain is the area adjacent to the stream channel that becomes inundated when the streamflow exceeds the capacity of the stream channel (See Figure on previous page). Federal and state agencies refer to the extent of the floodplain in terms of the anticipated frequency of streamflows that result in inundation (i.e. 10-year, 50-year, 100-year floodplains). The floodplain provides temporary storage area for floodwaters and sediment produced by the watershed. The velocity of the water flowing down the stream is drastically reduced as it flows out onto the floodplain. The reduced velocity of the water causes the suspended sediment to settle out on the floodplain.

2. The longitudinal dimension looks at the stream channel from its source in the mountains (or hills) to its terminus in a lake, ocean, or a larger stream. In this sense it is similar to taking a watershed view of the stream. The overall longitudinal profile of the stream can be simplified by dividing it into three zones: Headwaters Zone, Transfer Zone, and Depositional Zone (see Figure below). The headwaters zone, often referred to as the upper watershed, is typically characterized by steep



Watershed Stewardship

Basic Watershed Processes* continued

slopes and a steep stream gradient and is commonly the source of much of the sediment that moves down the stream. The transfer zone is typically characterized by gentler slopes and broadening valleys, through which the stream begins to meander. Some sediment is deposited in this zone, but often only temporarily. Most of the sediment is eventually ends up in the deposition zone, which is typically characterized by broad, nearly flat valley floors. It is important to note that erosion, transfer, and deposition occur in all zones, but the zone concept focuses on the most dominant processes in each zone.

The form of the channel typically changes as it moves through the three longitudinal zones. Channel form is commonly described by two characteristics: thread and sinuosity. Streams are referred to as either single or multiple thread streams. Single thread streams, which display one channel, are most common. Multiple thread streams typically take the form of a braided stream. Braided streams typically get their start when a central sediment bar begins to form in a channel due to reduced streamflow or an increase in sediment load. The central bar causes the water to split into two smaller channels on either side of the bar. The smaller channels have a smaller cross section resulting in higher velocity flow, which erodes the banks and causes the channel to widen. The new wider channel results in a reduced velocity and the formation of a new central bar and the process continues.

Sinuosity is the term used to describe the amount of curvature of a channel. The sinuosity for a given reach is computed by dividing the channel centerline length (the distance you would travel if floating down the stream) by the length of the valley centerline (the distance a bird would travel if flying over the stream). Streams typically become more sinuous (take on a meandering form) as their gradient or slope decreases.

Vegetation in the stream corridor also plays an important role in channel forming processes and the ecological function of the stream. Native vegetation in the stream corridor, whether it be in the channel, on the banks, or on the floodplain, can be thought to have evolved according to the physical channel forming processes described above. Vegetation plays its own physical role in affecting channel formation. This role can be indirect, such as reducing surface erosion on the upper slopes, which reduces sediment load in the stream. Vegetation can also have direct impacts on channel formation, such as riparian (streamside) vegetation that slows the velocity of the water and protects the banks from erosion. Simultaneously, vegetation in the stream corridor provides food and habitat for wildlife, fish, birds, and countless other organisms.

*The *Basic Watershed Processes* section is based on information from *Stream Corridor Restoration: Principles, Processes, and Practices.*

Permits and Regulations

12 Practical Tips for Getting Your Project Approved

1. Consult Early. Consultation with permitting and regulatory agencies should begin as early as possible in planning your project. This way potential concerns can be addressed and potential problems identified.

2. Carefully Select and Design Your Site. Evaluate several alternative sites and designs before making your choice.

3. Have Written Descriptions and Site Plans Available. You may need to provide a written description as well as a map and site plan of your project at your first meeting with each agency.

4. Learn the Rules. Take time to study the protocols and regulations of those agencies that must approve your project. Study all applicable federal, state, and local agency permitting requirements.

5. Know the Players. Become familiar with the regulators and how they function.

6. Approach the Process with a Positive, Non-Adversarial Attitude. It is generally counterproductive to resist the permit process as you are going through it. Indeed the squeaky wheel gets the grease. But be polite.

7. Reduce Adverse Environmental Impacts. Design your project to eliminate or reduce as many potential environmental impacts as possible. Consider environmentally superior alternatives. Incorporate suggestions you learned during early consultation.

8. Involve the Public. Meet with members of your community to get their ideas and views of your proposed project. Avoid surprises.

9. Pay Attention to Details. Follow all the rules. Respond promptly to requests for information. Do not cut corners.

10. Be Willing to Negotiate. The permit process has been established because of the public concern for protecting the waterways, and this is the prime responsibility of the agency reviewer. The reviewers are sensitive to the concerns of individuals and property rights and are willing to consider alternative project designs to meet the needs of the property owner and still protect natural resources.

11. When in Doubt, Ask. If you are not sure whether your project needs a permit, ask. Going ahead without all proper permits or without following conditions of approval will very likely cost you time and money.

12. Get Everything in Writing. Request each agency you contact put everything in writing. This will help prevent any misunderstandings.

Resource Concern-Possible Solutions List

Linking Your Resource Problem or Concern to Possible Solutions

Resource Concern	*Applicable Practices*
Streambank erosion	gr, hr, trm, glcd, tam, rb, ls, pp, ww, cr, bm, rbl, bt, rr, vr
Tamarisk and Arundo	tam, rb
Broadleaf weed infestation	ig/wc, npge, gm, fenge, h
Invasive annual grass infestation	ig/wc, npge, gm, fenge, h
Overgrazing	gm
Poor quality stock water	gm, sphe, rb
Road erosion/flooding	rcm, gr, hr, ecb, trm, bb, bl, lflpd, fenge
Roadside weed management	rcm, trm, fenge, glcd
Headcuts and gullies	gr, hr, trm, lflpd, m, lspp, ww
Small landslides/slope failures	m, ecb, bb, bl, lflpd
Crop pest management	fenge, h, hsp
Ag field erosion	fenge, h, glcd, cc, vfs, hsp
Ag water conservation	glcd, cc, vfs, hsp

Legend for Practices Codes

bb	Brush Box	lflpd	Live Fascines and Live Pole Drains
bl	Brush Layering	lspp	Live Staking and Pole Planting
bm	Brush Mattress	m	Mulching
bt	Brush Trench	npge	Native Perennial Grass Establishment
cc	Cover Crops	pp	Willow Wattles
cr	Coir Roles (Fiberscines)	rb	Riparian Buffers
ecb	Erosion Control Blankets	rbl	Reinforced Brush Layering
fenge	Farm Edge Native Grass Establishment	rcm	Road Construction and Maintenance
glcd	Grass-lined Canals & Ditches	rr	Rootwad Revetment
gm	Grazing Management	sphe	Stock Pond Habitat Enhancement
gr	Gully Repair	tam	Tamarisk and ArundoManagement
h	Hedgerows	trm	Turf Reinforcement Mats
hr	Headcut Repair	vfs	Vegetated Filter Strips
hsp	Habitat and Sediment Ponds	vr	Vegetated Riprap
ig/wc	Invasive Grass/Weed Control		

Conservation and Restoration Practices

List of Conservation and Restoration Practices

Upland and Rangeland Practices:

1. Invasive Grass/Weed Control
2. Native Perennial Grass Establishment
3. Stock Pond Habitat Enhancement
4. Grazing Management
5. Road Construction and Maintenance
6. Gully Repair
7. Headcut Repair
8. Turf Reinforcement Mats
9. Mulching
10. Erosion Control Blankets
11. Brush Box
12. Brush Layering
13. Live Fascines and Live Pole Drains

Lowland and Agricultural Land Practices:

1. Farm Edge Native Grass Establishment
2. Hedgerows
3. Grass-lined Canals & Ditches
4. Cover Crops
5. Vegetated Filter Strips
6. Habitat and Sediment Ponds

Riparian Area Practices:

1. Tamarisk and ArundoManagement
2. Riparian Buffers
3. Live Staking and Pole Planting
4. Willow Wattles
5. Coir Roles (Fiberschines)
6. Brush Mattress
7. Reinforced Brush Layering
8. Brush Trench
9. Rootwad Revetment
10. Vegetated Riprap

Invasive Grass/Weed Control

Jennifer Drewitz, Yolo County RCD

Description and Benefits of Invasive Grass/Weed Control

Weed control involves the containment, reduction, and/or elimination of certain plant species that are invasive and problematic in a rangeland system. Weed control methods include mechanical removal*, chemical applications*, cultural (grazing) practices, prescribed burning, biological control, revegetation with native species, and integrating various combinations of these methods. Weed control can lead to increases in native plant species, forage quality for wildlife and livestock, wildlife populations, plant diversity, and soil water availability. It can also decrease allergens, restore normal fire regimes into an area, and help prevent degradation of rivers and streams. Due to the variability among control methods and their effectiveness on different weed species, any weed control program requires consultation with the County Agricultural Commissioner, University Cooperative Extension Specialist, and/or local Pest Control Advisor.

Conditions Where Invasive Grass/Weed Control Applies

Although not all weed control techniques are practical at all locations, most methods can be applied in rangeland systems.

- Hand-pulling (and hand cutting), grubbing, and hoeing can be applied anywhere a person can access and are good options for controlling new (incipient), small infestations, or previously controlled weed infestations where plant density is low.
- Grazing (if the weed is palatable) can be done just about anywhere.
- Mowing is effective in areas accessible by mowing machinery, typically flat or gently sloping areas, and where soil erosion (i.e. stream banks) and desirable plant species vulnerable to soil compaction/large equipment are NOT a concern.
- Chemical herbicides can be applied anywhere authorized by the specific herbicide label and is one of the most efficient weed control methods. Many herbicides are registered for rangelands, and even some for use near water. Herbicides are a good tool to utilize on large weed infestations, such as yellow starthistle and/or with the particularly problematic species perennial pepperweed. Once a weed infestation is reduced, other methods can be integrated without significant loss of efficiency.
- Prescribed burning can be done in most situations depending on the slope of the terrain and experience of the burn crew.

Materials Needed

Hand pulling, grubbing, and hoeing: leather gloves, grubbing hoe, mattock (head with both axe and hoe), shovel, bags (to collect plants if containing seed).

Mowers: different types include the sickle-bar mower, rotary mower, flail and reel mower.

Hand cutting tools: hand sickles, scythes, machetes, brush/weed cutter.

Chemical:

- *Chemical:* herbicide, adjuvant (surfactant or spreader), water, dye, soap, paper towels, absorptive material for spills (kitty litter), graduated cylinder or measuring cup, eye protection, tyvex jumpsuit, rubber gloves and shoes, long sleeve shirt and long pants, permits from ag commissioners office if necessary, herbicide label, location of nearest hospital, notepad to record amount of herbicide used and rate for county records.
- *Application Equipment:* back pack sprayer (for spot applications), boom (for wider spray coverage); ATV, spray tank, and boom (for large area application); airplane/helicopter with tank and boom (extremely large scale applications), label containing name of chemical being used and applicator contact information.

Invasive Grass/Weed Control

Implementation

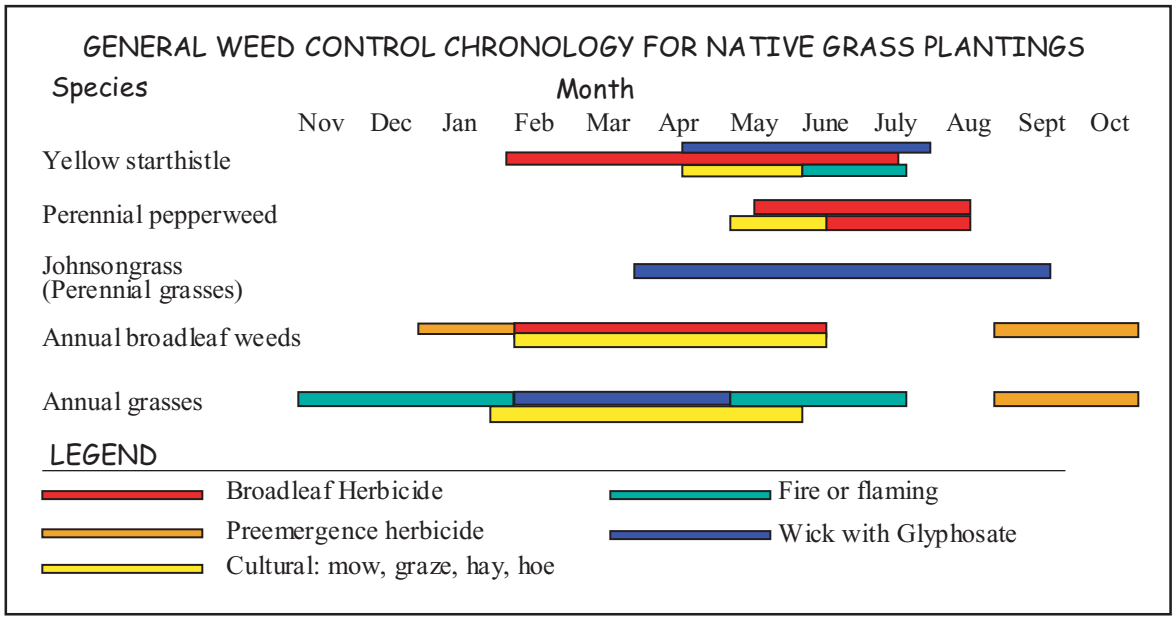
Focus weed control techniques initially on the perimeter of source populations and progress toward the heart or center of the weed population. This will contain the spread of the weed while control measures are being taken.

Mechanical control:
Plants that resprout from underground roots and structures, like perennial pepperweed will not be controlled using this method unless the entire root system can also be removed. Shallow rooted species, like barbed goatgrass and medusahead can be controlled by hand pulling. Yellow starthistle can also be controlled this way as long as the root crown can be removed and the soil is moist. *Steps:* With gloves on grasp weed as close to ground as possible, pull out. If stem breaks off with part remaining in the ground, it may resprout. Soil may be too dry. Plants should be able to be pulled out with part of the root attached to be effectively controlled. This should be done after flowering but prior to seed maturation and dispersal for maximum efficacy. Plants can be bagged (recommended if seed has been produced) and removed from the site, piled for decomposition or burning, or left in place. Certain species resprout readily if the soil is moist and should be repositioned or removed from the site.

Mowing and grazing:
Mowing and grazing helps reduce seed production but timing and growth stage of the plant are critical. Repeated mowing or grazing when the plant is just about to flower can be very effective at reducing seed production in annual plants and depleting underground storage carbohydrates of perennial plants. *Steps:* Mow or graze the weed below the lowest growing branch (2-4inches). If plants resprout, mow or graze again post flowering but before seed maturation or dispersal. Repeat to avoid seed production. May result in low branching pattern. This is very effective if competitive grasses are mixed in with the weeds forcing the weeds to branch higher and resulting in a more effective kill using mowing or grazing. Thatch can be hayed, burned, removed from the site, or left on site to act as a mulch. If thatch contains seeds or propagules of the weed, leave on site to avoid spreading the weed to non invaded areas.

Chemical control:

- Preemergent selective herbicides used in rangeland/grassland system can target broadleaf weeds such as yellow starthistle and perennial pepperweed and allow grass species to persist.
- Preemergent broad spectrum herbicides can be used to control discrete populations of weed species within a rangeland system if selectively making spot applications with a backpack sprayer or wick applicator.
- Contact your local County Agricultural Commissioner for details on spraying herbicides: Yolo County Agricultural Commissioner, 70 Cottonwood St., Woodland, CA 95696, (530) 666-8140.



Native Perennial Grass Establishment

Vance Howard, Yolo County RCD

Description and Benefits of Native Perennial Grasses

The focus of this practice is on the establishment of stands of native perennial grass in rangeland or otherwise large acreage settings. For the use of native perennial grasses in cropland and roadside settings see the *Farm Edge Native Grass Establishment* practice in this manual. Over the past 150 years California has seen a shift in its grassland vegetation from a mixture of perennial grasses and annual grasses/forbs to a system dominated by annual grasses/forbs (many of them introduced and invasive). Armed with rapid growth and prolific seed production, annual grasses effectively compete with slow-growing, long-lived native perennial grasses for light and soil water. For this reason reestablishing native perennial grasses requires careful human management of the land, as well as patience. This practice will cover the general guidelines to follow for reestablishing perennial grasses on Yolo County's grasslands and oak woodlands. Native perennial grasses provide many benefits, including deep rooting, which allows for deeper water penetration into the soil in the winter. This in turn can help reduce soil compaction. Many perennial grasses remain green longer than annuals and can provide good forage for grazing animals.

Conditions Where Native Perennial Grass Establishment Applies

Native perennial grasses can be reestablished in any grassland or oak woodland, regardless of current land management. Actively grazed rangelands can provide an ideal opportunity for native perennial grass establishment, although changes will most likely need to be made in grazing management. The techniques outlined in this practice will apply more specifically to rangeland areas in Western Yolo County, such as the foothills of the coastal range, the Dunnigan Hills, and the Capay Valley. See *Farm Edge Native Grass Establishment* for techniques more appropriate for level pasturelands and previously farmed land.

Materials Needed

Site preparation/weed control:

- Tractor or ATV equipped with a spray tank and boom.
- Broad spectrum herbicide (e.g. glyphosate)
- Prescribed Burn Equipment: including Nomex jumpsuit, drip torch or other ignition device, backpack sprayer, burn plan and permits, shovels and McClouds, assistance from CDF or an experienced crew.

Seeding:

- Tractor equipped with a No-till seed drill; or a seed broadcaster and harrow.
- Native perennial grass seed.

Maintenance:

- Tractor or ATV equipped with a spray tank and boom.
- Selective herbicides (e.g. Transline) and broad spectrum herbicides (e.g. glyphosate)
- Prescribed Burn Equipment
- Also see materials needed for *Invasive Plant/Weed Control.*

References

Robins, P., R. Bresnick Holmes, and K. Laddish, ed. 2001. *Bring Farm Edges Back to Life!* 5th edition. Yolo County Resource Conservation District.

Native Perennial Grass Establishment

Implementation

Like other practices that involve native perennial grass establishment, it is best to think of this practice as having three phases: site preparation/weed control, seeding, maintenance. Reestablishing native perennial grasses on your land is a long term commitment that will require careful planning and diligent maintenance to be successful. Timing is also critical during all phases.

Site preparation/weed control: The first step is selecting a site. Site attributes such as soil type and quality, existing vegetation, slope, aspect, average precipitation, accessibility, current/future use, and size should all be considered. By assessing these site attributes you will determine how your project will proceed. The environmental attributes, from soil quality to precipitation, are key for determining the various appropriate native perennial species for the site. Work with your seed supplier to determine the appropriate mix of species and application rates.

Once you have selected a site and determined that it can sustain native perennial grasses you must prepare the site for seeding. The emphasis on site preparation is thatch and weed seed reduction. For the purposes of establishing native perennial grasses, any non-native annual grass or herbaceous broadleaf plant is considered a weed. There are three primary techniques for weed control in rangeland settings: grazing, prescribed burning, and herbicides. Existing vegetation will determine the preferred weed control managment. If annual grasses dominate the site, the following strategy should be employed: Heavy grazing in the spring just prior to setting of seed, a prescribed burn in late summer/early fall and an application of glyphosate to combat the first flush of weeds following the first rain (if necessasary) should provide the best environment for seeding.

Seeding: October and November are typically the optimal months for planting. Keep track of the weather patterns and plan to plant so that the seed will not sit on the ground too long before a good, germinating rain. Ideally, a small rain event in September or early October will promote the germination of remaining weed seeds and glyphosate can be applied prior to or shortly after the native perennials have been seeded. Seeding should be done using a no-till range drill designed to handle fluffy seeds, such as the Truax drill, which was designed for prairie restoration in the Mid-West. Native perennial grass seeds germinate slower that annuals, typically 2-4 weeks (depending on temperature) following the first germinating rain.

Maintenance: Maintenance intensity will diminish as the native perennials become established, but the first 2-5 years are crucial. As with site preparation, maintenance focusses on weed control with the goal of reducing competition. Now that the native perennial grasses have been planted, herbicide use must be more selective. Once again, grazing or mowing the site in the spring following planting can reduce seed production of annuals. If broadleaf annuals, such as Yellow starthistle, are the dominant weeds found emerging in the spring, a selective broadleaf herbicide can be applied. A wick application of glyphosate using an ATV or tractor mounted wick applicator in the spring is another option. A pre-emergence herbicide can be applied in the fall prior to the first rain event. Burning the site the first spring following planting is not recommended, but prescribed burns can be one of the most cost effective methods for weed control. Burning, along with grazing and mowing are the preferred techniques for long term maintenance. Burns should be conducted in the late spring (in general) and not more that once every two to three years. The Nature Conservancy and the California Department of Forestry (CDF) are good resources for more specific prescribed burn information.

Stock Pond Habitat Enhancement

Vance Howard, Yolo County RCD

Description and Benefits of Stock Pond Habitat Enhancement

Stock ponds are ponds that have been constructed in rangeland settings to provide a water source for livestock. This practice will describe enhancements that can be made to existing stock ponds, which will result in improved water quality for the livestock and the creation of wildlife habitat. Studies have demonstrated that cattle health and weight gain are improved when they are provided with clean water. Enhancing stock ponds to benefit livestock involves fencing off the pond and providing a trough that draws water from the pond by the use of a pump or gravity (referred to as an "off pond watering system"). Enhancing stock ponds to benefit wildlife also includes fencing off the pond, but with a "wildlife friendly" fence (see other side for more details). Additionally, the fenced off area is planted with native plants. The vegetation provides food, nesting habitat, and cover for insects, birds, and other animals.

Conditions Where Stock Pond Habitat Enhancement Applies

Enhancement of stock ponds can be undertaken for ponds of any size and water holding capacity. Full implementation (i.e. fencing, off pond watering system, planting of trees, shrubs, grasses, forbs, rushes and sedges) of this practice is best suited to stock ponds that hold water all year. Smaller ponds and ponds that are dry for up to half of the year are still suitable for partial implementation (i.e. fencing, off pond watering system, limited planting of grasses, forbs, rushes and sedges). In either case, fencing off the pond and providing for an off pond watering system will give the rancher the most benefit to his/her operation. The extent of the plantings is determined by the conditions of the site, the ability to provide supplemental irrigation, and the desire of the rancher to devote some time to regular maintenance.

Materials Needed

- Small Tractor or ATV: for preparation and maintenance of the fenced area; needs the ability attach a discing implement, mower, and herbicide spray boom.
- Hand Tools: shovels, rakes, hoes, dibble sticks, sledge hammer, 5 gal. bucket, fence wire tool.
- Drip Irrigation System
- Off Pond Watering System: pump (solar or gravity pumps work best), storage tank, trough, pvc, solar panel.
- Fencing: posts, barbed wire, smooth (wildlife friendly) wire.
- Native Plants: trees, shrubs, forbs, grasses, sedges and rushes.

References

USDA NRCS Grazing Lands Technology Institute. 1997. *National Range and Pasture Handbook.*

Vallentine, John R. 1989. *Range Development and Improvements* 3rd edition. Academic Press.

Stock Pond Habitat Enhancement

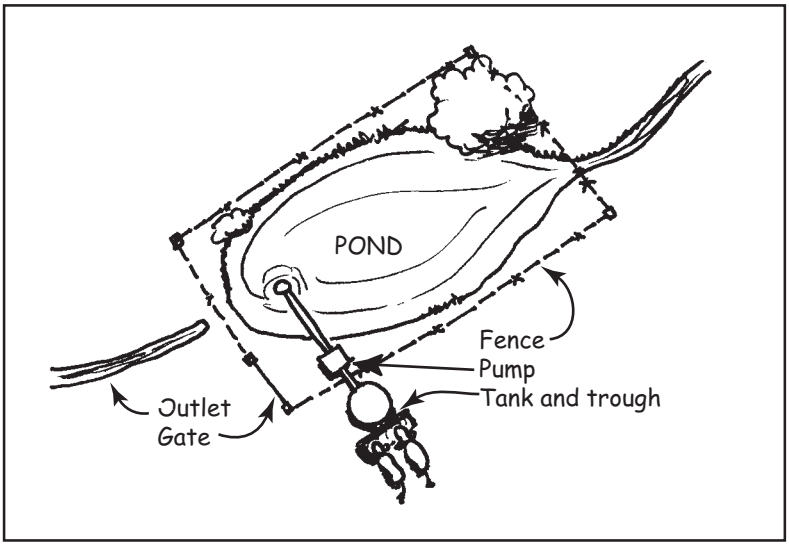
Implementation

There are three main components to stock pond habitat enhancement - fencing, off pond watering system, and native plantings. Careful planning should be done prior to breaking ground. Work with your local NRCS and/or RCD office to determine the cost effectiveness of your plan and the additional benefits you can expect to see. NRCS and RCD staff can also provide technical assistance in planning your project and may be able to match you with a cost-share program that will make your project more affordable.

Fencing: Install a 5-wire fence around the pond. The size of the fenced area depends on the extent of the plantings you want to undertake as well as the location of other fences and the topographical limitations of the area. If keeping the cattle out of the pond and providing them with a watering trough is your primary goal, the fenced area need not be much larger than the pond. If you intend to improve the wildlife habitat around the pond, the fence should allow for at least a 20 foot buffer around the pond. Use a smooth wire, instead of the normal barbed wire, for the top and bottom wires of the fence to allow for safe movement of wildlife in and out of the pond area. A gate in the fence will simplify your maintenance and recreational access to the pond as well as allow for future "flash grazing" as a vegetation management tool.

Off Pond Watering System: These systems can vary widely depending on the site and the number of cattle and the number of fields that will use the system. In fact, the systems are too varied and too complicated to adequately explain here. If you are unfamiliar with such systems working with your local NRCS engineer can save you a lot of time and money. Their technical assistance is at no cost to you and they may be able to match you with a cost-share program. Two general examples of off pond watering systems are as follows: 1) The use of a solar pump to pump water to a storage tank on a small rise, which gravity feeds the water to one or more troughs in one or more fields; 2) A more simple approach is to use a siphon pump to pull water from the pond and gravity feed it directly to the trough.

Native Plantings: Planting native vegetation to provide habitat for wildlife will require several years of maintenance to the area while the plants become established. It will also require considerable work to prepare (i.e. weed control) the site for planting. See *Hedgerows* and *Riparian Buffers* for details on establishing native plants. However, some simple and inexpensive planting options do exist. These low/no maintenance options may be preferable for the busy rancher. Basically, consider planting just at the waters edge using sedges and rushes. These can be purchased as "plugs" and planted in the winter or early spring. If you have rushes or sedges growing along the streams on your land you can dig some of these up, separate them and plant them at the pond. Additionally, live cuttings of willow and cottonwood can be planted at the waters edge. See *Live Staking and Pole Planting* for details on how to harvest, handle and plant these live cuttings. None of these plantings will require supplemental watering or future maintenance (just keep the livestock from trampling or eating them), although you may need to install cages around the live cuttings to discourage browsing by herbivores.



Grazing Management

Stephen Jaouen, NRCS

Description and Benefits of Grazing Management

The primary conservation practice that is used to meet the needs of Grazing Management is prescribed grazing. Prescribed grazing is the controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve a specified objective. These objectives are developed by the landowner during the planning process. At a minimum prescribed grazing would include enough information for the landowner to know the proper amount of harvest to maintain enough cover to protect soil and maintain or improve the quality and quantity of desired vegetation. Balancing the available forage with the number of grazing and browsing animals is key to effective grazing management. Proper grazing management can increase production and protect the natural resources that rangelands provide.

Conditions Where Grazing Management Applies

Annual Grasslands:
California annual grasslands should be managed to insure proper residual dry matter (RDM) for the next growing season. Annual forage responds to conditions that influence plant germination and establishment in the fall. Although fall weather has the greatest impact on annual plant growth, the water holding capacity of the soil and RDM also influences growth. How to recognize RDM levels is described under Implementation. High levels of RDM tend to favor plants such as Ripgut brome, Wild oats, Medusa-head, and Barbed goat grass. Low levels of RDM tend to favor plants including Silver hairgrass, Yellow starthistle, Filaree, Turkey-mullin, Tarweeds, Vinegar weed, Clover and Bur-clover. Management of annual grasses should focus on moderate levels of RDM. Landowners should test these guidelines and develop their own levels to meet their specific site and condition requirements.

Perennial Grasslands:
California perennial grasses are found within many range sites and need to be managed in a different way if restoring perennial grasses to the ranch is a management objective. Native perennial grasses developed with natural wildlife herd movements. Herds tended to focus on a specific site and move frequently due to predator pressures. These types of high intensity short duration grazing systems favor longer-lived, deeper-rooted perennial grass systems. Perennial grass systems tend to have higher infiltration rates, better soil quality characteristics, and longer “green” periods due to their extensive root systems that reach depths of over 3 feet.

Managing your ranch for both annual grasses and perennial grasses can benefit production in many ways. Annual grasses produce high amounts of digestible protein in a short amount of time. Using proper management can utilize these “green” periods while they occur. Perennial grasses can extend this “green” period by a few months. The need for supplemental inputs may be reduces by this extension of “green” forage.

Materials Needed

Annual Grasslands:

- Management of RDM for annual rangeland is rather straightforward and easy to apply.
- Visual Determination: Photo standards developed for the Central Valley foothills at the San Joaquin Experimental Range.
- Weight determinations: A square foot frame, clippers and a gram scale.

Perennial Grasslands:

- Measurements for perennial grass systems are harder because perennial grass is influenced by conditions in current and preceding years. To understand the effects of management one must monitor the utilization of the key perennial species.
- Visual Determination: Photo monitoring points, plant recognition, and plant utilization.

References

USDA NRCS Grazing Lands Technology Institute. *National Range and Pasture Handbook. 1997.*

United States Department of Interior--Bureau of Land Managment. *Utilization Studies and Residual Measurements. 1996.* Interagency Technical Reference 1734-3.

Grazing Management

Implementation

RDM measurements: Measurements are taken in the late summer to early fall.

Photo by USDA-NRCS

Visual determination:

- *Light Grazing* – leaves little or no patchy appearance. Plant matter averages 3 or more inches in height and small objects (golf ball) are masked. RDM is over 800 pounds per acre.
- *Moderate Grazing* – leaves an average of 2 inches of unused plat matter and has a patchy appearance with little bare soil. Small objects are hidden at 20 feet away or more. RDM is 400 to 700 pounds per acre.
- *Heavy Grazing* – leaves less than 2 inches of unused plant matter. Small objects and areas of bare soil are visible from 20 feet. RDM is less than 400 pounds per acre.

Weight determination:

Ten samples should be made over a range site. Randomly pick a spot to measure and place the frame on the ground. Clip at approximately ½ inch off the ground. Put all clipped material and litter or shattered plant material into a sack and weigh with the gram scale (be sure to measure and subtract the weight of the sack). Grams per square foot multiplied by 96 gives you pounds per acre. Example: 9 grams per square foot X 96 = 864 pounds per acre. Stocking rates can be figured from this data to reach guideline levels.

Perennial measurements:

- *Photo Points* – A photo point of the perennial stand you wish to manage should be taken each year in late spring when the annual grass and forbs have gone dormant but the perennials are still green. This will allow you to see the perennials in the photo. A photo point can be a pole in a fence line, a tree, or other permanent structure. Taking the photo properly along with documenting exposure, shutter speed, and the type of film is important.
- *Plant Recognition* – Using plant ID guides can help. However, if you can not identify the key perennial plant you wish to manage contact your local Resource Conservation District.
- *Utilization* – The concern here is the amount of photosynthetically active material (green blades) remaining for the plant to recover from grazing. Generally, less than 40 percent defoliation will not inhibit plant growth. However, one must give the plant time to grow before the dormant season. Perennials should not be grazed between early March and late May. This will allow the defoliated plants to grow and produce seed. Watch these areas over time to see the trend of the system.

For more information on annual or perennial rangeland, and the monitoring aspects please contact your local Resource Conservation District or U.C. Livestock Advisor.

Websites to visit for more information:

http://agronomy.ucdavis.edu/calrng/range1.htm

http://danrrec.ucdavis.edu/

http://www.glci.org/

http://srm.org/

http://www.ftw.nrcs.usda.gov/glti/homepage.html

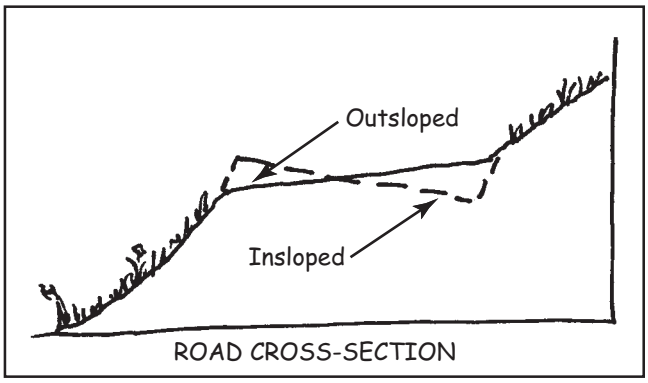
Road Construction and Maintenance

Vance Howard, Yolo County RCD

Description and Benefits of Proper Road Construction and Maintenance

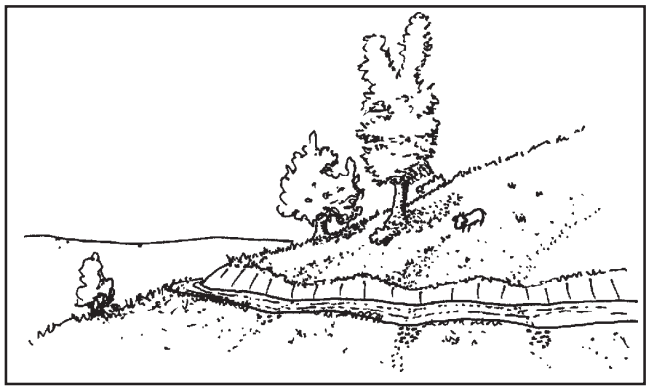
The construction, reconstruction and maintenance of forest and ranch roads are important and complex subjects. So complex, in fact, that it is recommended that you consult the "Handbook for Forest and Ranch Roads," (Weaver, W.E. and D.K. Hagans, 1994) if you intend to do any major road work. Therefore, this practice covers only a few techniques that if properly implemented will result in multiple benefits, including: reduced annual maintenance, reduced erosion, reduced sedimentation of water courses, improved natural drainage, improved reliability, and overall reduced costs. The techniques include outsloping, rolling dips, and proper culvert installation.

Outsloping describes a road that is graded so that the inboard edge is higher than the outer edge (see Figure at right). This allows for sheet flow of runoff across the road. Sheet flow is very low energy and causes minimal, if any, damage to the road. Rolling dips look like long drawn-out waterbars (see Figure below), which makes them easily passible by large and small vehicles alike. Rolling dips do not plug up or break down and fail like waterbars. They are placed where small swales cross the road or at regular intervals when the slope of the road is greater than 8%. Culverts should be sized and installed to pass the expected 50- or 100-year flow and with the lowest possible diversion potential.



Conditions Where Road Construction and Maintenance Applies

Existing or planned forest and ranch roads that do not have an overly steep grade and that are built on stable fillslopes are typically well suited to outsloping. Rolling dips need to be installed on outsloped roads that exceed eight percent. (Weaver and Hagans, 1994). The focus of culvert installation for this practice is limited to small ephemeral (flow during and after storm events only) and intermittent (seasonal) stream crossings. Many of the concepts outlined in this practice can also be applied to the construction and maintenance of trails; the only difference is the scale.



Materials / Equipment Needed

Road Construction / Reconstruction:

- Heavy Equipment - One or more of the following: hydraulic excavator, bulldozer, loader, grader, water truck, dump truck.
- Culverts for stream crossings (various sizes)
- Gravel for the road surface (if needed)
- Straw bales
- Native grass/legume/wildflower seed mix - rely on the advice of the seed distributor to select the best mix for your site.

Road Maintenance:

- Heavy Equipment - backhoe, grader, bulldozer.
- Gravel for the road surface (if needed)

References

Weaver, W.E. and D.K. Hagans. 1994. Handbook for Forest and Ranch Roads. Mendicino County Resource Conservation District.

Road Construction and Maintenance

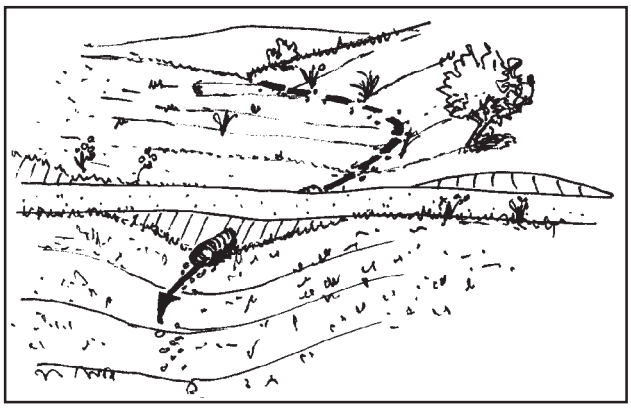
Implementation

Unless you are proficient with the use of the various types of heavy equipment needed, it is recommended that you research and contract with a road construction company or heavy equipment operator for any road work. For many, road construction and maintenance is not a "do-it-yourself" practice, and you will save time and money by first researching and requesting quotes from contractors and then selecting the contractor that best fits your needs.

Most forest and ranch roads require annual maintenance to remain passable and useful. Sometimes maintenance needs are minor (i.e. regrade a few ruts), but sometimes heavy precipitation over the winter causes major problems (i.e. washouts, stream diversions, large ruts) making the road impassable. Annual maintenance can be time consuming and costly. The problem with many existing forest and ranch roads is that they were designed and built to capture runoff and transport it in ditches and culverts. The inboard ditches and culverts need ongoing maintenance to function properly. Without it they inevitably fail, causing damage to the road. The following are the basics you need to know about outsloping, rolling dips, and culverts. They are intended to make it easier for you to assess and discuss your road maintenance needs with your road maintenance contractor. Again, if you plan to do the work yourself, purchase a copy of the *Handbook for Forest and Ranch Roads*.

Outsloping: The key to outsloping is to disperse (not concentrate) and drain runoff from the road surface along its entire outer edge (not in an inboard ditch). Most insloped roads have an inboard ditch and a berm on the outer edge of the road surface. Changing an insloped road into an outsloped road requires removing the berm and placing the spoils in the inboard ditch, which becomes part of the road surface. The road surface is then graded with an outsloped pitch with a drop of 3/8" to 1" per foot depending on the road grade (4% = 3/8" / ft.; 5% = 1/2" / ft.; 6% = 5/8" / ft.; 7% = 3/4" / ft.; 8% or more = 1" / ft.). The outer edge of the road should be planted with a mix of native grasses, legumes, and wildflowers (25 lbs. / acre) and covered with straw mulch (1 bale per 700-1,000 sq. ft.) for erosion control.

Rolling Dips: Rolling dips are smooth angled depressions in the road surface. They should have a long shallow approach on the up-road side and a more abrupt rise on the down-road side (see Figure). In general they are built at a 30 to 45 degree angle to the road, with a grade of at least 1% greater than the road. There are two situations where rolling dips are necessary on an outsloped road. First, a rolling dip needs to be installed at every swale that intersects the road. Unlike an insloped road that captures uphill runoff in a ditch before it reaches the road surface, outsloped roads allow the runoff to flow across the road and continue down the natural swale. The key is to not concentrate the runoff or allow it to divert down the road surface. The second situation is when the road grade is greater than 8% and the runoff tends to divert down the road surface before it can drain across the road. Often the rolling dips placed at the swales are sufficient to drain the road surface before rills and gullies form. When there are no swale crossings and the road grade is greater than 8%, rolling dips should be built at regular intervals. The distance between rolling dips depends on the road grade, road surface material, and anticipated rainfall. The best thing to do is to look at other roads with a similar grade and surface in your area to see when runoff begins to create rills. In some cases rills can form in less than 10 feet, in which case the road would need to be a series of rolling dips.



Culverts: Culverts should be installed at most ephemeral and intermittent stream crossings. In some cases low water crossings and bridges are more practical applications. A non-scientific rule of thumb for deciding when to install a culvert as opposed to a rolling dip is to look for exposed rocks, roots or bare soil in the swale uphill of the road. These would indicate that the swale receives sufficient flow to cause erosion, thus a culvert would be a good choice. The two most important aspects to culvert installation are size and alignment. The culvert should be sized to pass the anticipated 100-year storm flow. Use the culvert sizing worksheet in the appendix. The culvert should be aligned with and placed in the natural stream bed so that flow enters and exits the culvert without having to turn. A rolling dip should be built at all stream crossings, whether a culvert is installed or not. This insures that if the culvert becomes plugged and fails that the water can flow over the road and continue down the stream channel and not divert down the road. This simple practice can mean the difference between the loss of a crossing (worst case) and the loss of hundreds of feet of road.

Headcut Repair

Vance Howard, Yolo County RCD

Description and Benefits of Repairing Headcuts

A headcut is typically found at the upstream end of a gully, although some cases several headcuts may be observed in a single gully. Each headcut, with the exception of the uppermost headcut, represents a former nickpoint and can continue to cause downcutting of the channel. Water pours over the headcut like a small waterfall, causing bank erosion and undercutting the base of the headcut, causing it to "migrate" upstream. To slow or stop this migration and continued erosion, the headcut must be stabilized. This practice will outline several techniques for stabilizing headcuts. In general the headcut is regraded to a more stable angle and the soil is covered by a variety of materials, from soil and concrete filled sandbags to rock riprap. If the area has year-round moisture, vegetation can be planted to further stabilize the banks. Keep in mind that gullies (and headcuts) are typically symptoms of a larger problem. First identify and treat the larger problem (see *Gully Repair*).

Conditions Where Headcut Repair Applies

The techniques described for headcut repair apply to ephemeral and intermittent streams and drainages. Headcuts should be repaired only after the cause of the gully has been identified and treated. The headcut can be caused by overland or subsurface flows. There must be enough space upstream of the headcut to pull back the bank to at least a 2:1 slope. Work should be done when the stream or drainage is dry.

Materials Needed

- Heavy equipment: backhoe
- Hand tools: shovel, rake, McCleod, sledge hammer, 4' concrete stake
- Filter fabric (also known as geotextile fabric)
- Landscape staples
- Sandbags
- Wooden stakes (1" x 2" x 2')
- Willow stakes (if moist conditions exitst)
- Rock riprap
- Concrete
- Native grass/legume/wildflower seed mix - rely on the advice of the seed distributor to select the best mix for your site.

References

McCullah, J.A. 1999. *Erosion Draw 3.0 CD-ROM*. Salix Applied Earthcare.

Headcut Repair

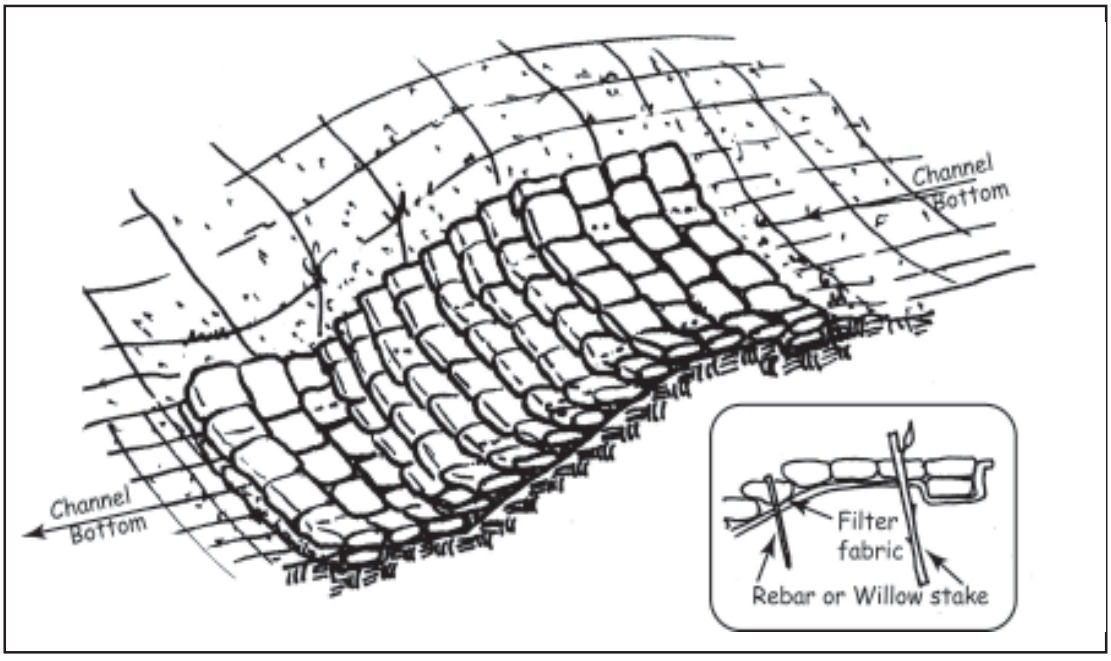
Implementation

Repairing headcuts can be a simple, straight-forward operation. Access to the site can determine the suitability and cost effectiveness of the various techniques used to repair headcuts. Topography and vegetation can limit the equipment that can reach the site. Minimal disturbance to the existing landscape should be a primary goal for any technique.

All Sites and Techniques: Pull back the headcut and adjacent banks to at least a 2:1 slope using a backhoe or hand tools. Further excavate where sandbags or rock riprap will be placed (the channel bed) so that they will be level with the adjacent banks (see Figure). Dig a small trench at the base of the slope of the channel to key in the sandbags or rock riprap. Dig another small trench at least four feet upstream from the top of the slope of the channel and at least one foot uphill from the top of the banks to key in the filter fabric. Smooth the surface of the new channel and banks, seed with native grasses, and lay the filter fabric over the area. Begin by laying the filter fabric in the channel, from trench to trench. Use a single piece if the filter fabric is wide enough to extend up the banks. If more than one piece is used, lay additional pieces similar to the first piece (from downstream to upstream) being sure to overlap at least one foot with the previous piece. Staple the filter fabric in place using landscape staples every 1-2 feet and starting in the channel and working your way upstream and upslope. It is very important to key in the top of the filter fabric (see *Turf Reinforcement Mats* or *Erosion Control Blankets* for details). Once the area has been reshaped and the filter fabric secured, you can choose the option below that best fits the location and the project budget.

Rock Riprap: This is the least labor intensive technique. Delivery and ability to place rock is the limiting factor. Place rock riprap in the channel section of the reshaped slope. Begin by placing the largest rocks in the trench at the base of the slope and work your way to the upstream trench. In most cases one layer of rock will suffice. Choose quarried (angular) rock that with diameters that averages 1/4 to 1/3 of the width of the channel bed. For example, if the channel bed is two feet wide, choose rock with a 6” to 8” average diameter. Willow stakes can be installed in the adjacent banks using the concrete stake and sledge hammer to create a pilot hole.

Soil and Concrete Filled Sandbags: Fill sandbags with a 50-50 mix of soil and concrete. Another option is to sew your own filter fabric ‘sandbags’ and fill them with only soil. Securely staple the open end of each sandbag closed. Place the sandbags in the channel section of the reshaped slope. Lay the first row of sand bags in the trench at the base of the slope with the stapled end upstream. Stagger the next row so that each sand bag is centered on the seem between the two under it. Continue to the upstream trench. Secure every third sandbag by first creating a pilot hole with the concrete stake and driving a wooden stake into the pilot hole through the sandbag.



Hedgerows

Vance Howard, Yolo County RCD

Description and Benefits of Hedgerows

Hedgerows are rows or groups of trees, shrubs, perennial forbs, and grasses that are planted along field edges or other unused areas. Hedgerows typically consist of native plants, which require minimal maintenance once established. These native plant hedgerows can provide many benefits to an agricultural operation. They can reduce wind and water erosion, improve the permeability of the soil, suppress weeds by direct competition, provide wildlife habitat, and probably most importantly provide habitat for beneficial insects. Hedgerows can also filter surface runoff and subsurface flows, preventing excess sediment, nutrients, and pesticides from entering waterways. An often overlooked benefit of hedgerows is the improvement to the aesthetics of the farm landscape.

Conditions Where Hedgerows Apply

Hedgerows are appropriate for areas between fields, adjacent to roads and roadside ditches, and next to canals or streams. Because of the many benefits associated with hedgerows, they can be installed in agricultural and nonagricultural situations. In either case, site selection is important and there are three main considerations to account for. First, there needs to be access to water for irrigating the hedgerow plantings for the first 2-3 years of establishment. Second, the site needs to be not vulnerable to flooding, which will kill most of the native plants suited to dry conditions. Third, consider what equipment is used on the adjacent fields, roads, or canals, and be sure that the hedgerow will not hinder proper use of this equipment.

Materials Needed

- Small Tractor or ATV: for discing, leveling, mowing and applying herbicide to the site.
- Hand Tools: shovels, rakes, dibble sticks, 5 gal. bucket.
- Lawn mower and/or Weed Wacker
- Drip Irrigation System
- Native Plants: trees, shrubs, perennial forbs and grasses.
- Herbicide: backpack sprayer and/or wick applicator.
- Mulch: wood chips, crushed walnut shells, other suitalbe material.
- “No Spray, No Disc” sign from the Yolo County RCD

References

Robins, P., R. Bresnick Holmes, and K. Laddish, ed. 2001. *Bring Farm Edges Back to Life!* 5th edition. Yolo County Resource Conservation District.

Hedgerows

Implementation

Select a Site: The first step is to select a site. The site should have access to water, be well drained, and not conflict with normal equipment operations. Choose a site that will give the most benefits to your operation and that best fits your needs. The length and width of the site will vary. Greater widths will allow for more complex plantings (i.e. various species of native trees, shrubs, forbs and grasses).

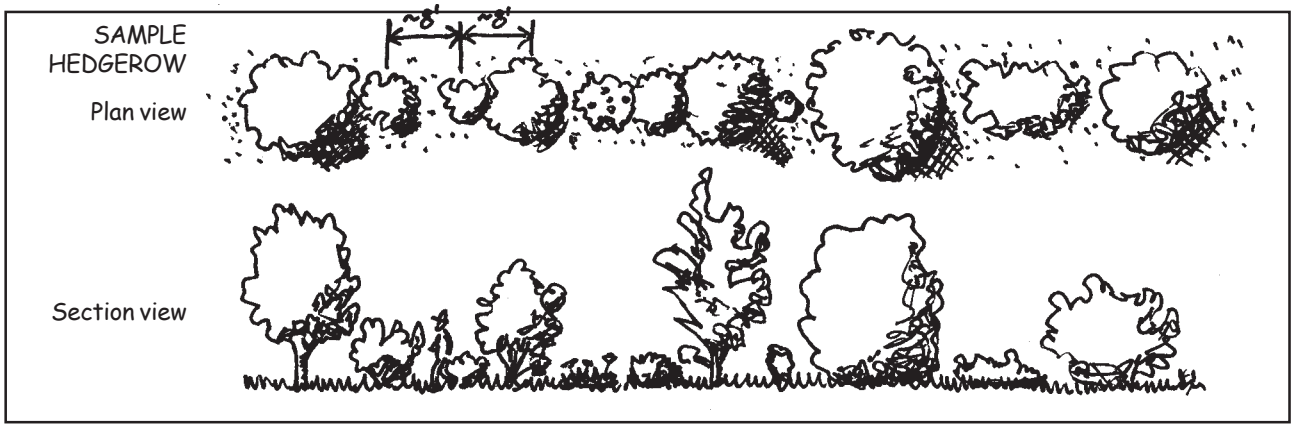
Draw a Plan: It will be very helpful for you to draw a scale site plan for your hedgerow. Begin by drawing the existing site, including any features that will remain (e.g. trees, fences, canals, roads). After you have decided on the plant species to include in your hedgerow, overlay the existing site plan with a planting plan that indicates the species and spacing of the plantings. Overlay the planting plan with an irrigation system plan that shows the water source and indicates the sizes of the irrigation tubing/pipe and the gph rate of the emitters for the various species.

Site Preparation and Weed Control: It will be likely that your chosen hedgerow site will have weeds growing on it. If so, you will need to plan your weed control strategy to begin at least one year prior to planting your hedgerow. One approach may be to first establish a ground layer of native grasses and forbs during the first two years, followed by planting trees and shrubs the third year. Refer to *Invasive Grass/Weed Control* and *Farm Edge Native Grass Establishment* in this manual for details on site preparation. If you are fortunate and have a weed free site to work with, then disc the area in the late summer or early fall to make the soil workable. A flush of weeds may appear after the first rains following the discing. These can be treated with a broad spectrum herbicide before the area is planted.

Plant Selection: First identify any variability in the soil characteristics at your site. Work with your local nursery or plant expert to choose the plant species that are best suited to the soil, moisture, and other characteristics of your site. Further refine your plant selection based on the intended purpose of the hedgerow. Contact an IPM specialist to determine what plant species will attract insects that will most benefit your crops. The most successful hedgerows (i.e. most benefits) are those with a combination of trees, shrubs, forbs and grasses. In some situations, the tree and shrub plantings may need protection from herbivores. Metal wire cages work well, provided protection while allowing for natural growth. Planting should be done from late fall through spring.

Irrigation: Identify your water source and assess water delivery capabilities. Design either a drip (preferred) or furrow irrigation system. Determine the watering needs of the plant species you chose and work with your local irrigation supplier to select needed materials. The irrigation system will be used for the first 2-3 years to provide supplemental watering during the dry season until the plants have developed an adequate root system.

Maintenance: Hedgerows require regular maintenance during the 2-3 year establishment period. A major maintenance need is weed control. Spot spraying or wicking with herbicide in the spring and fall can be effective. A well-timed mowing in the spring to reduce the weed seed bank is another option. The most effective weed control for hedgerows without grass or forb plantings is a 6 inch layer of mulch (wood chips, crushed walnut shells, etc.) over the entire area. At the very least, placing a ring of wood chip mulch around each plant can have several benefits. The irrigation system should be checked often during the period of use. Cages may need to be installed around some tree and shrub plantings. Occasionally a plant may die and need to be replaced.



Grass-lined Canals & Ditches

Jeanette Wrysinski, Yolo County RCD

Description and Benefits of Grass-lined Canals & Ditches

A grass-lined ditch or canal refers to a waterway with banks that contain permanently established, non-weedy vegetation rather than bare soil and weeds. This approach to canal bank maintenance can reduce or eliminate most herbicide application and stabilize the banks - thus improving water quality, reduce the need for annual ditch cleaning, and provide waterside habitat for a variety of small wildlife. All of this can be accomplished without significantly impeding water flow.

Photo by Chris Rose

A variety of vegetation types are used on canal banks in order to accomodate the changing water levels throughout the spring and summer. Typically, dryland grass species are planted on the top portions of the canal, often near a road edge. Grasses that tolerate summer water are planted on the slopes, and sedges and rushes are planted at the water-line because they are more tolerant of continuous inundation and are small enough that they do not significantly affect water flow.

Conditions Where Grass-lined Canals & Ditches Apply

Nearly all permanent supply or drainage canals can be planted with perennial vegetation. Temporary ditches that are pulled or taken down on an annual basis are not appropriate for this practice.

Materials Needed

Some equipment, such as a tractor or ATV plus sprayer will be needed. If no herbicide is used, fencing may be needed to contain grazing animals, or burning safety equipment if a burn is used for weed control. Equipment needs for canal bank planting is minimal. The upper, dry edges of the canal bank may be seeded with a small, broadcast seeder that is pulled by an ATV, or with a belly-grinder. This “upland” portion should then be harrowed. Other vegetation is typically planted as “plugs,” which are 1" x 1" x 3" root-volume plants, that are hand-planted into the sloped banks. When planting plugs, a dibble-stick is useful. This is a long or short handled implement with a metal base that is the shape of a plug. It is used to create the correct sized planting hole for plugs and can increase the efficiency of planting time, especially when working in pairs. A “No Spray, No Disc” sign can be purchased from the Yolo County RCD and posted at each end of the hedgerow.

References

Robins, P., R. Bresnick Holmes, and K. Laddish, ed. 2001. *Bring Farm Edges Back to Life!* 5th edition. Yolo County Resource Conservation District.

Grass-lined Canals & Ditches

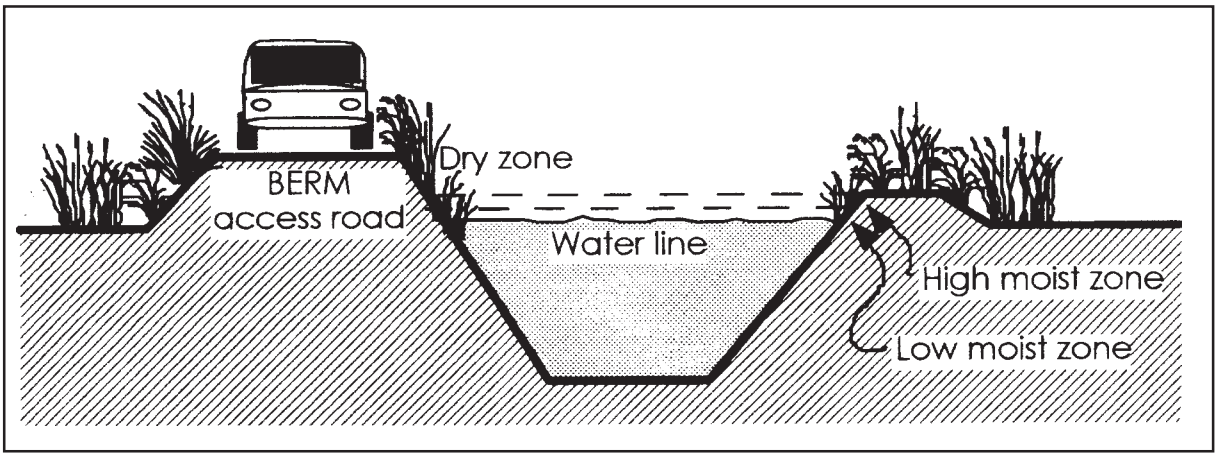
Implementation

Site Preparation:
Select a section of canal bank for revegetation and begin the weed control process at least one year before the expected planting date. Use weed control appropriate to the farm, the area, and downstream water users. Weed control on canal banks can be especially difficult, so be diligent. Use a combination of herbicides, mowing, discing, grazing, and burning to reduce or eliminate the weeds on the upland as well as the sloped portion of the banks. If possible, re-grade the canal banks to a 3:1 slope to ease planting and maintenance.

Planting:
In the fall, when good germinating rains are expected, plant an appropriate native grass seed mix, using the method of your choice, on the upland portion of the bank. Lightly harrow in the seed. If weather allows, grass, sedge, and rush plugs can also be hand-planted on the bank portions that are too steep for a planter. Most sedge species are only available as transplants (plugs). If high water flows are a risk after a fall planting, it may be necessary to plant into bank-stabilization fabric. This is a bio-degradable mat that will protect bare portions of the bank from damaging flows. See *Turf Reinforcement Mats* and *Erosion Control Blankets* for details on installing erosion control fabrics. If weather is uncooperative, transplanting on the steeper banks can also be done in the spring.

Maintenance:
During the first, and possibly the second growing season, some irrigation may be necessary to get the planting well established. The need for irrigation will depend on the canal size, plant distance from the water table, and soil type.

A successful canal bank planting will depend on diligent weed control during the first two years. One aspect of post-establishment weed control can include the use of spring and summer applications of selective, broadleaf herbicides applied either pre-or post emergence. Well-timed mowings can be an effective means of controlling weedy annual grasses as well as broadleafs within the planting of native bunch grasses. If mowing, time the mowing according to plant growth stage. Mowing is most effective for reducing weeds if done when the weeds have begun the reproductive phase (flowering and seed production) and before the seeds are mature. Cut to a height that will remove the majority of the broadleaf or annual grassy weed, but minimize the effect on the natives. Native perennial bunchgrasses will typically be much shorter than annual weeds in the first year, and in subsequent years can tolerate mowing well. Maintenance in subsequent years might involve application of a pre-emergent herbicide in the fall (select herbicides approved for use near waterways), further well-timed mowings, grazing and the occasional prescribed burn.



Cover Crops

Paul Robins, Yolo County RCD

Description and Benefits of Cover Crops

Cover crops have been grown in agricultural situations in California since the early part of the last century. They have been used in perennial crops and in a variety of field and row crops, either as an integral part of the annual cropping system or as a rotational crop. Cover crops are associated with soil benefits such as improved tilth and fertility, reduced erosion and crusting, and increased water-holding capacity. Field margins, roadsides, banks, levees and slopes can also be planted with cover crops for weed suppression. Cover crops also provide valuable cover, nesting and foraging habitat for a variety of wildlife and can support beneficial insects, which aid in pest control.

A variety of perennial and annual grasses and forbs (broadleafed plants) can be used for cover crops as either single- species or multi-species mixes depending on the farmer's needs. Fast-growing grass species provide high biomass for boosting organic matter in the soil, while some species of legumes can provide high volumes of nitrogen for the following cash crop. Mixed cover crops can be used to provide a combination of biomass and crop nutrient production. "Green manure" cover crops are typically incorporated into the soil before a cash crop is planted. In an orchard or vineyard setting, many annual cover crops can be managed to self-seed, minimizing needs for replanting and soil disturbance. Perennial grass cover crops can provide basic soil cover, and are typically selected to minimize water and sunlight competition with adjacent trees and vines.

Conditions Where Cover Crops Apply

Cover cropping is useful in a variety of agronomic situations where either rainfall or adequate irrigation are available. In an annual cropping system, the cover crop can be planted after harvest of one crop and before planting of the next to provide soil management and fertility benefits. In a perennial cropping system, a cover crop can be managed between plant rows for similar benefits.

Materials Needed

The basic ingredients for a cover crop are outlined below:

- Seed & inoculum (for legumes)
- Standard farming equipment for bed preparation, planting, incorporation and smoothing could include disk, harrow, planer or roller, seed drill or broadcaster, power mulcher, and herbicide. Choice of tools is dependent upon the farmer's choice and available equipment.
- Mower (for cover crops in orchard and vineyard settings or for cover crop "knock down")
- Standard irrigation equipment and/or rainfall

References

Wrysinski, Jeanette. "Cover Crops for Agriculture and Wildlife." *Valley Habitats*, Number 15. Ducks Unlimited, Inc. 1996.

University of California Sustainable Agriculture Research and Education Program (UC SAREP)

Cover Crops

Implementation

Before a cover crop is planted, a suitable seedbed should be prepared. This is usually started after the post-harvest irrigation for perennial crops or after seedbed preparation for annual crops. On farmland, light disking or some other form of tillage is usually sufficient for most cover crops. Disking should be followed by some smoothing operation such as floating or planing so that larger clods are broken and the seedbed is smooth. This is particularly important for smaller seeded cover crops such as clovers. In non-tillage orchards, or with shallow-rooted citrus trees, care should be taken not to till too deeply where a large percentage of tree roots may have grown near the surface.

Unless non-leguminous or grass-only cover crops are used, additional fertilizer is not usually required for cover crops. Otherwise, follow your seed company representative's recommendation for fertilizer type and rate. Excess nitrogen fertilizer may actually reduce overall nitrogen fixation and give weedy species a competitive edge.

Prior to planting, mixes including large-seeded legumes should be inoculated with the appropriate rhizobial bacteria. Host-specific bacteria work in combination with special root structures to bind or 'fix' nitrogen into plant tissues. Some seed is sold pre-inoculated, but large-seeded legumes such as vetch, peas and beans should be inoculated immediately before planting at a rate of about 8 oz. of inoculum per 100 lb. of seed and layering it into the planter hopper. If the seed is broadcast rather than drilled, it should be wet-inoculated to provide better adhesion of the inoculum to the seed.

For planting, the cover crop seed can be broadcast or drilled in. Drilling may require less ground preparation, and is the method of choice for first-time plantings. For single species or larger seeded types, an alfalfa drill can be used. Broadcasting seed is faster and less expensive, but will require a light harrowing to incorporate the seed followed by a final floating or rolling to finish the seedbed. In established perennial cover crops, supplemental seeding may be needed every 2-5 years.

If fall rains are not expected immediately, a light irrigation will settle soil around the seed and hasten germination. Summer annual cover crops will require regular irrigations just as any other warm season crop.

In orchards or vineyards, two to six mowings, beginning in February or March, may be needed from cover crop planting until the cash crop is harvested. If self-seeding is desired, mowing should be delayed until the cover crop has matured seed. When mowing a cover crop mix that includes legumes, care should be taken to not cut below the growing point, or re-growth will be hindered. Mowing, spot-spraying or hand-hoeing may be needed to keep sprinkler or drip emitters clear, but using low-growing cover crops or extending sprinkler risers could reduce the need for such maintenance.

Incorporation of the cover crop (if necessary) should be timed to allow at least two weeks of decomposition in the soil before planting. Timing of incorporation should also be made in consideration of adequate soil moisture for decomposition, otherwise additional irrigation may be necessary to adequately break down the organic matter for proper seedbed preparation for the following crop. In spring, care must also be taken not to enter a field with excessive soil moisture, which would obviously hinder equipment access and also damage the soil with excessive compaction and clodding. The simplest scenario for cover crop incorporation involves "knocking down" the cover crop with either mowing or herbicide, followed by disking the plant material into the soil. After a period of decomposition, the soil surface would then be reshaped and smoothed, as needed. Power incorporators such as the Wilcox Performer have also been used in Yolo County without any other equipment to chop and incorporate a cover crop and prepare the bed for the following cash crop in as few as three passes with ideal soil conditions.

Habitat and Tailwater Ponds

Paul Robins, Yolo County RCD

Description and Benefits of Habitat and Tailwater Ponds

Not only do ponds offer solutions to widely-recognized surface water quality problems, they provide valuable wildlife habitat and enhance ground water recharge. Without intervention, irrigation water turns into unrestricted runoff, bringing about a series of problems. Irrigated row crop fields that drain to one or several main low spots often empty into an initial drainage system that then dumps into a main water conveyance channel (canal or slough). Silt-laden runoff results both from summer irrigation and from winter storms. Runoff not only removes topsoil from farmland but deposits this resource downstream, at unwanted places throughout the watershed and beyond. For Yolo farmers, it makes much more sense to recapture this lost resource and re-use it or return it to our groundwater storage systems.

Construction of a small double-pond system is a straightforward, cost-effective solution to all these problems that catches and stores at least part of the runoff water. The double-pond design works efficiently by making the first, small pond work as a sediment trap, engineered for easy excavation of silt that is easily replaced on the field during fall groundwork. This in turn reduces the maintenance requirements for the second, larger pond, which can serve multiple purposes: water storage, ground water recharge, water return systems, and plant and wildlife habitat (See photo).

Conditions Where Habitat and Tailwater Ponds Apply

A two-stage tailwater pond is best situated at the low end of a field that receives regular summer irrigation runoff (typically from surface irrigation). Depending on one's goals for the pond, either sandy or clay soil would be desirable to either facilitate percolation of water into the ground or retainment of water for a year-round pond. The amount of land required to accommodate a pond depends on the size of pond needed or desired as well as plans for creating any associated upland wildlife habitat adjacent to the pond. For a two-stage pond, space must be allowed for equipment access for periodic cleaning of the sediment trap and more infrequent (i.e. every 5-10 years) maintenance of the large pond.

Materials Needed

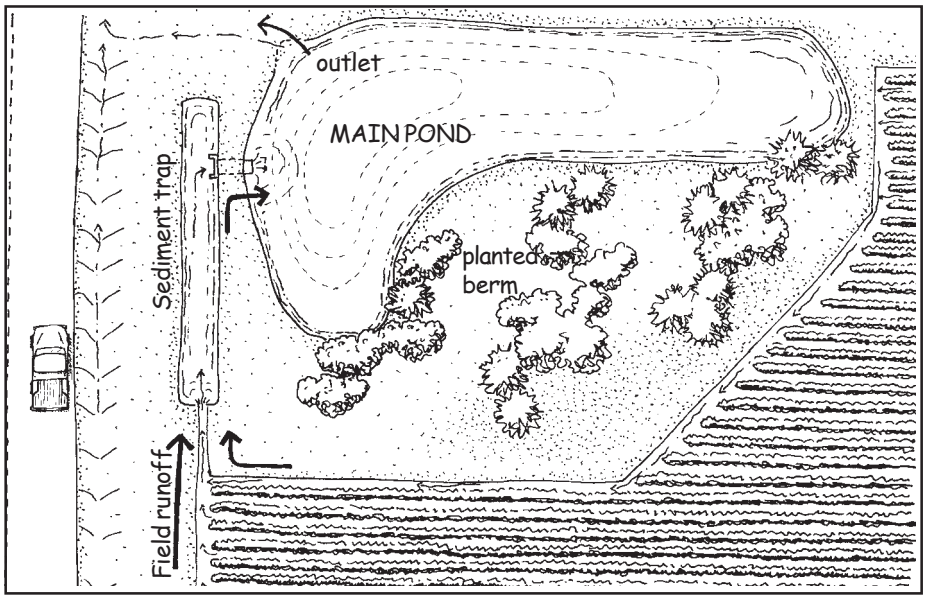
- Earthmoving equipment such as an excavator or backhoe
- Water control structures for pond inlet and outlet (culverts and/or flashboard risers are typical)
- Return pump (typ. 5 hp) and 6-8" pvc pipe if a return system is planned
- Planting materials for pond banks and berms/uplands if desired:
- Native grass/legume/wildflower seed, plugs for waterline plants and trees and shrubs, live stakes for trees such as willow and cottonwood

References

Robins, P., R. Bresnick Holmes, and K. Laddish, ed. 2001. *Bring Farm Edges Back to Life!* 5th edition. Yolo County Resource Conservation District.

Habitat and Sediment Ponds

Implementation



The main pond can be designed with a natural shape rather than the usual long, narrow trench of some return systems. The curved 'L' shape in the accompanying illustration is easy to construct with standard scrapers. A gradual 3:1 or 4:1 slope (meaning for every 3 or 4 feet of horizontal distance there is 1 foot of fall) with a deep center portion is preferable. For stability purposes, no slopes should be steeper than 1:1. The pond should also not be less than 5 feet deep, to minimize the encroachment of unwanted weeds. As water percolates or evaporates, the pond surface simply decreases in circumference. Wildlife will continue to use it even when it turns into a puddle. The gradual slope also creates several moist soil planting zones for the establishment of wetland species that can compete against unwanted weeds.

The overall size of your pond could vary greatly, depending on whether it will be used to capture and hold tailwater for wildlife only or to also recirculate that water for irrigation. If you are planning a tailwater recirculating system (tailwater return system), pond and pump sizing will depend on how you manage crop irrigations. Factors to consider in the design of the pond and the sizing of the pump and flashboard risers are the amount of irrigation water you will be running, (measured in cubic feet per second (cfs) or gal./min.), whether you will be running half or full sets, and the amount of runoff. For pond design purposes runoff is usually considered to be approximately 25% of the amount of water applied in a surface irrigation. Another important factor is whether you will be returning the water to the upper end of the same field or sending it downstream to another field. With such a variety of scenarios for recirculating systems, it is important to consult with someone that has experience in pond design, such as your local NRCS engineer or a private consultant.

If you plan to have your pond simply slow and retain a portion of irrigation runoff, sizing and design is mostly a matter of how much space you have or how much land you are willing to take out of production. The pond inlets and outlets will still need to be sized according to anticipated flows. A common size would be a 1-acre area in a 100 acre field, usually in the lowest corner. Half of the 1-acre pond site would be occupied by the pond, and the other half by a landscaped mound created by excavation spoil. The mound provides structural diversity to the landscape, which will in turn encourage the establishment or use of a wider variety of plants and animals. The mound also reduces the expense of moving the dirt during excavation. However, in order to maintain slope stability, any berms or mounds created from the pond spoils should not be closer than 12 feet from the pond edge. If you want to minimize the loss of farmable acres, the pond spoils could also be redistributed over the field.

Water control structures, such as drop pipes, flashboard risers, or weir boxes, are important for controlling water movement and water levels in the sediment trap and pond. A flashboard riser, for example, should be used as the entry point from the sediment trap to the pond and should also be used at the pond outlet. The pipe barrel should not be less than 12 inches in diameter to reduce clogging from debris. The riser, or upright part of the structure, is always larger (approx. 1.5 x barrel diameter) and is based on the maximum water expected to come through the structure during a given storm or irrigation event. An NRCS engineer can assist in determining appropriate sizing. Riser heights are standard at three or four feet and up, but it should always be high enough to see in order to avoid equipment damage. A steel stake can be a good marker.

Tamarisk and Arundo Management

Vance Howard, Yolo County RCD

Description and Benefits of Tamarisk and Arundo Management

This practice describes several management techniques for control and eradication of Tamarisk and Arundo. Tamarisk (*Tamarix spp.*), also known as Salt cedar, is a non-native woody plant that aggressively invades riparian (streamside) areas, displacing and replacing native vegetation. It is a long-lived plant that produces large quantities of small seed every year. Tamarisk consumes large quantities of water and accumulates salts in its leaves. As leaf litter accumulates under the plant the soil becomes highly saline, inhibiting the establishment of other plants. Arundo (*Arundo donax*), also known as Giant reed, is a fast growing, bamboo-like plant in the grass family that grows in dense, multi-stemmed clumps in and adjacent to stream channels. It spreads by way of rhizomes, quickly forming large colonies that displace native vegetation. Managing Tamarisk and Arundo can improve riparian wildlife habitat and reduce flooding and erosion problems.

Conditions Where Tamarisk and Arundo Management Applies

This practice applies to any area that is infested with Tamarisk and/or Arundo. Different techniques may be needed to control and eradicate Tamarisk and Arundo depending on the size of the infestation, the terrain, the weather, adjacent land use, and the amount of adjacent native vegetation. The "spray only" technique is appropriate for large infestations with little to no native vegetation. The "cut, resprout, and spray" technique is appropriate for small to large areas with interspersed native vegetation, however it is very labor intensive. The "cut stump" technique is better suited to moderate to small infestations that are mixed with healthy stands of native vegetation. It is also labor intensive. The "root removal" technique works well for moderate to small infestations and will most likely require the use of heavy equipment.

Materials Needed

- Heavy Equipment: bulldozer, backhoe, excavator (with rotary chopper attachment), farm tractor
- Hand tools: anvil loppers, chainsaw, handsaw, shovels, rakes, gloves
- Large wood chipper
- Herbicide: triclopyr, imazapyr, glyphosate
- Herbicide application equipment: see *Invasive Grass/Weed Control* for list of equipment

References

State of California, California Department of Fish and Game. 1999. *Arundo: A Landowner Handbook.*
Carpenter, Alan T. 1998. *Element Stewardship Abstracts for Tamarisk.* The Nature Conservancy.

Tamarisk and Arundo Management

Implementation

All but one of the techniques below involves the application of herbicide. The use of herbicides to control and eradicate Tamarisk and Arundo on your property may require an applicator's permit, depending on the type of herbicide you use, the size of the project area, and whether you are the applicator. Contact the Yolo County Agricultural Commissioner's office (530-666-8140) for more information. Any work being done in the stream channel may require a Streambed Alteration Agreement from the California Department of Fish and Game. Contact the local CDFG warden for a consultation.

Spray Only:
This technique is best suited for large stands consisting of only Tamarisk and Arundo. For Arundo, spray the leaves and stems of the plants with a systemic herbicide such as glyphosate. For Tamarisk, spray the leaves and stems with imazapyr. The foliar herbicide application should be done in late summer or fall. Care should be taken not to spray adjacent native vegetation. Do not cut the plants for at least 6 months. Follow up applications, in late summer or fall, will be required for at least three years.

Cut, Resprout, and Spray:
This highly effective technique is well suited to small and large stands of Tamarisk and Arundo interspersed with native vegetation. Cut Tamarisk and Arundo in late spring or summer to about 1-3 feet above the ground. Cutting can be done using anvil loppers, chainsaws, handsaws, or a special rotary chopper that attaches to the arm of an excavator. The cut vegetation can be hauled off site, left where it fell or run through a chipper on-site and used as mulch, or gathered into piles on-site and burned or left to decompose. All cut vegetation should be removed from the stream channel, or fragments can root and resprout where they lodge downstream after a high flow event.

Allow the Tamarisk and Arundo to resprout and grow for 2-3 months. In late summer or fall do a foliar herbicide application. For Arundo, spray the leaves and stems of the plants with a systemic herbicide such as glyphosate (e.g. Roundup® or its aquatic equivalent Rodeo®). For Tamarisk, spray the leaves and stems with imazapyr (e.g. Arsenal®) or imazapyr in combination with glyphosate. Do not cut the plants for at least six months. Repeat the procedure for 3-5 years.

Cut Stump:
This technique is well suited to moderate to small stands of Tamarisk and Arundo where healthy stands of native vegetation also exist. Cut Tamarisk and Arundo in late summer or fall to about 1-2 feet above the ground. Cutting can be done using anvil loppers, chainsaws, handsaws or a special rotary chopper that attaches to the arm of an excavator. Remove the cut vegetation from the project site or run it through a wood chipper and use it as mulch on-site. Working in teams of 2 or 3, one person cutting and two people applying herbicide, cut the remaining stumps to within 3" of the ground and treat the perimeter of each stump with a concentrate herbicide within a couple of minutes. For Arundo, use undiluted glyphosate or other appropriate herbicide. For Tamarisk, use triclopyr or imazapyr. Treat resprouts with a foliar herbicide application the following year. Monitor the project site for at least three to five years and spot spray any regrowth each fall.

Root Removal:
This moderately effective technique is well suited for moderate to small stands of Tamarisk and Arundo where the application of herbicide is not permissible. Use a bulldozer, backhoe, excavator or other piece of farm equipment to pull, push, or dig entire plants out of the ground. The stumps and any cut vegetation can be hauled off site, run through a chipper on-site and used as mulch, or gathered into piles on-site and burned or left to decompose. All cut vegetation should be removed from the stream channel. Removing plants in the spring, while the soil is still moist, will make the job much easier, although removal can be done anytime. Any roots, rhizomes, or stems left behind may resprout, so this technique should be repeated annually. Regrade disturbed soil.

Revegetation:
Revegetation with native grasses, shrubs, and trees is important to the overall recovery of the project site. Revegetation efforts should be planned so as not to interfere with the techniques for Tamarisk and Arundo control and eradication. In some cases, revegetation of the project site should be delayed until the second or third year of the project. See *Riparian Buffers, Native Perennial Grass Establishment,* and *Hedgerows* for more details on revegetation.

Riparian Buffers

Vance Howard, Yolo County RCD

Description and Benefits of Riparian Buffers

Riparian areas are lands adjacent to rivers, streams, sloughs, wetlands, and other waterways. The availability of water and flooding patterns (i.e. floodplains) define the extent of the riparian area. Both factors provide for a unique assemblage of vegetation. Some of the plant species commonly associated with riparian areas include Willow, Cottonwood, Valley oak, Sycamore, Elderberry, Mule fat, California wild grape, and many grasses and sedges. This riparian vegetation provides protection from streambank erosion and influences, to a certain extent, the shape of the waterway it is adjacent to. Riparian areas and the associated floodplains are designed by nature to accommodate flood waters during high flow events. Riparian areas provide valuable habitat for fish and wildlife. Riparian area restoration projects can vary in size and scope depending on the size of the waterway and adjacent land use activities. A project may be as simple as identifying the floodplain and extent of the riparian zone and planting a mixture of riparian plant species. In some cases the channel may have incised (downcut) and/or widened to the extent that a floodplain no longer exists. In such cases the channel may need to be reshaped, which is too complicated of a process to adequately describe in this text. Restoring riparian vegetation can provide numerous ecological and economic benefits. Well-established riparian vegetation can help protect against streambank erosion, while also providing habitat for fish and wildlife. This practice of restoring riparian vegetation is also referred to as creating riparian buffers. Riparian buffers can be useful in agricultural settings, as the above ground vegetation intercepts sediment- and nutrient-rich surface runoff, and the roots take up nutrients from the subsurface runoff, in effect filtering the agricultural runoff before it reaches the stream.

Conditions Where Riparian Buffers Apply

"Less than ten percent of the Central Valley's original riparian cover remains." (Barbour et al, 1994) There are endless opportunities to restore riparian areas. Riparian buffers can be planted along any waterway, from large rivers to small drainage swales, where riparian vegetation historically existed. Riparian vegetation can also be planted alongside human-made irrigation canals and ditches, although canal and ditch maintenance needs to be factored into the planning process. The size and scope of the restoration project and the vegetation to be planted will depend on many factors. Size of the waterway, the existence and extent of its associated floodplain, and adjacent land use determine the boundaries of the project site. The timing and seasonality of water flow in the channel and the depth to the water table will determine the appropriate vegetation for the site.

Materials Needed

- Heavy equipment: Backhoe with a "Stinger" attachment; farm tractor
- Hand tools: Shovels, hoes, rakes, post hole diggers, picks, 5-gal. bucket, gloves
- Riparian plants: see plant list on page 77
- Plant protectors: Fencing, rebar, metal t-posts
- Mulch: Wood chips, straw, crushed walnut shells
- Irrigation system

References

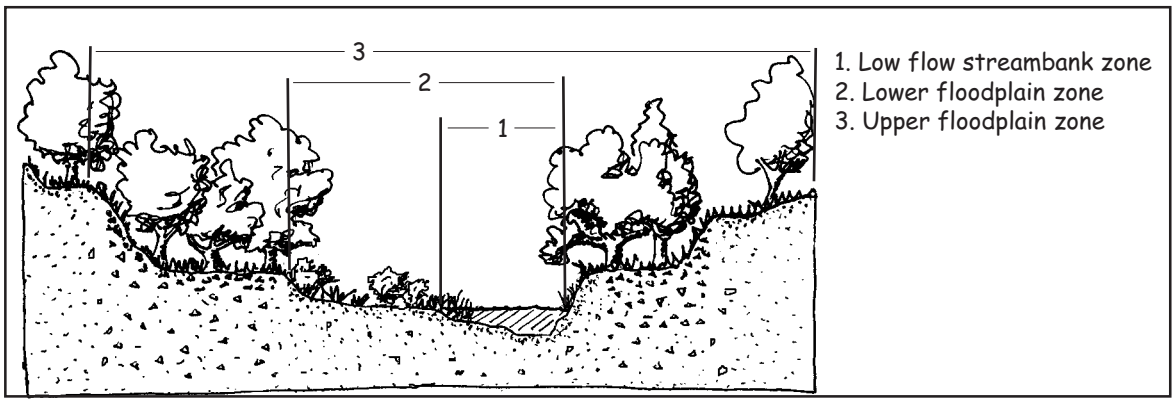
Robins, P., R. Bresnick Holmes, and K. Laddish, ed. 2001. *Bring Farm Edges Back to Life!* 5th edition. Yolo County Resource Conservation District.

Barbour, M. et al. 1994. *California's Changing Landscapes*. California Native Plant Society.

Riparian Buffers

Implementation

- Restoring riparian areas may require permits from the California Department of Fish and Game, the Army Corps of Engineers, and the State Water Resources Control Board. Contact your Fish and Game warden for consultation during the site selection and planning phases of your project. Chances are if there are no endangered species on the site and work is kept out of the channel, you won't need any permits.
- Site selection is an important first step. Determine if your waterway exhibits a floodplain. Check the depth to the water table. Check soil types. Take note of existing vegetation. Is it native or non-native? Will the removal of non-native vegetation be a part of your project? Assess adjacent land use activities. Is supplemental irrigation available? Choose a site that will best be able to support the vegetation after an initial establishment period of 3-5 years. Access to and availability of water in the soil is your main concern.
- Expect to spend as much time, if not more, planning your riparian buffer project as you do for actually doing the work. Drawing a map of your site will help. On your map you will want to identify the low flow channel, the hydrologic floodplain, and the topographic floodplain (See *Watershed Basics* for more information). Also note any existing vegetation, structures (e.g. bridge piers, irrigation pumps, etc.), roads, and erosion sites.
- Now that you have selected and mapped your site, it is time to decide what you want to plant and where you want to plant it. Referencing an adjacent healthy riparian area can tell you a lot about what species grow and how they are distributed. If a healthy riparian reference reach is not available, use your map and knowledge of the height and frequency of flows to determine planting zones. In general, you should delineate three zones: low-flow (or summer flow) streambank vegetation zone - mostly rushes, grasses and sedges; lower (hydrologic) floodplain vegetation zone - mostly shrub-like plants able to withstand inundation; and upper (topographic) floodplain zone - a mixture of grasses, shrubs, and trees. For riparian areas adjacent to agricultural fields a fourth zone of primarily grasses and forbs can be planted between the field and the riparian plantings (See *Vegetated Filter Strips*).
- Refer to the *Riparian Area Plant List* in this manual for native plant species commonly found in the different zones in the Cache Creek watershed. You will also want to work with one of the local native plant nurseries to decide what plants are most appropriate for your site and to determine what plants are available. Whether you are planting in one zone or in all four, choose several species for each zone. Delineate on your site plan the extent of the plantings in each zone and what species will be planted there.
- In general it is best to plant vegetation from late fall through early spring. Planting on the low-flow channel streambank and on the lower floodplain may not be possible during periods of high flow associated with winter storms. Planting these zones may need to occur in the spring. It is not necessary to plant the trees, shrubs, etc. in rows or at regular intervals, although this can make irrigation easier. It may be best to plant the riparian vegetation in clusters of 3-5 plants. The plants can be different species.
- Maintaining the plantings is vital to the success of the project. Protective cages may need to be built around the trees and shrubs to protect from herbivore browsing. Four to five foot wire fencing works best. Cut the fencing and wrap it around the planting to create a circular enclosure at least 3 feet in diameter. Stake the wire cage down using rebar or fence stakes. Mulching around the plantings with woodchips or other type of mulch will help control weeds. Irrigating the plantings during the summer (or when otherwise dry conditions exist) for the first three years is important to the success of the plantings. Create a wide, shallow watering basin for each plant. Provide the plants with a deep watering once a week. You can use whatever method (i.e. drip irrigation, flood, sprinkler, 5-gal bucket, hose) of irrigation that is available.



Live Staking and Pole Planting

Vance Howard, Yolo County RCD

Description and Benefits of Live Staking and Pole Planting

Both live staking and pole planting involve the insertion of live, rootable vegetative cuttings into the ground. If correctly prepared and placed, the live stakes and poles will develop a root system and vegetated shoots. Live stakes are typically 1/2" to 2" in diameter and 3' to 4' in length. Pole cuttings are typically 1" to 3" in diameter and 4' to 10' in length. Willow and cottonwood are most commonly used for live staking and pole planting. The root system serves to stabilize the soil, protecting it from erosion. When planted near a stream or in the floodplain, the shoots reduce the velocity of the water during high flows, resulting in sediment accumulation. When planted in a regular pattern on a streambank or slope, live stakes serve to anchor the soil.

Conditions Where Live Staking and Pole Planting Apply

Live stakes can be used in upland and riparian (streamside) areas. Live stakes can be used alone, but they are often combined with other biotechnical practices. Live stakes are used in upland areas to stabilize eroding gullies and small slumps. Live stakes can be used to anchor and enhance habitat benefits of erosion control blankets and turf reinforcement mats, willow wattles, straw wattles, and other erosion control products. Live stakes can be added to such hard structures as riprap and gabions to provide added soil stabilization and improved wildlife habitat. Live stakes need to be planted in an area where the roots will have year-round access to water or where irrigation can be provided during the dry season for the first 3-5 years of establishment.

Pole plantings are mostly used in streamside and floodplain areas. They are ideal for project sites with widely fluctuating water tables and areas where supplemental irrigation is not feasible. Pole plantings can be used alone, but they are often combined with other biotechnical practices. Poles can be added to such hard structures as riprap and gabions during installation to provide added soil stabilization and improved wildlife habitat. Pole planting usually requires the use of heavy equipment (typically a backhoe). Be sure your project site is accessible to heavy equipment.

Materials Needed

There are three phases to live staking. A flatbed or pickup may be needed to transport cuttings from the harvest site to the storage site and to the planting site.

Harvest:
Large, healthy stand of willow or cottonwood
Large loppers (anvil type works best), hand pruners, pruning saw or small chainsaw
Rope or twine

Storage:
Some means to keep the cuttings wet for 1 to 30 days, such as a lake or pond, a stream, or burlap and sprinklers.

Planting:
Large loppers (anvil type works best), hand pruners, pruning saw or small chainsaw
Small sledge hammer and a dead blow mallet
A 4-foot concrete stake or a gas powered auger

References

McCullah, J.A. 2000. *BioDraw 1.0 CD-ROM*. Salix Applied Earthcare.
State of California, California Department of Fish and Game. 1998. *California Salmonid Stream Habitat Restoration Manual*. Third edition.
United States Department of Agriculture, Natural Resource Conservation Service (USDA-NRCS). 1998. *The Practical Streambank Bioengineering Guide*.

Live Staking and Pole Planting

Implementation

There are three phases to live staking and pole planting: Harvest, Storage, and Planting.

Harvest:
Stakes and poles should be harvested during the plant's dormant season (typically November through April). Live stakes and pole cuttings should be cut from straight, healthy 2-5 year old branches. Do not "clear cut" your harvest stand, rather thin out the branches that will make the best live stakes and not compromise the stand. Try to harvest from plants that are growing near to where you will be planting. If there is not a suitable harvest stand in the immediate area, harvest from a stand that is growing in similar conditions to your planting site. Branches that have already begun flowering (i.e. bud swell) will not root as well because rooting hormones are translocating to support flowering.

Suitable stakes are 1/2" to2" in diameter and should be cut into 3' to 4' lengths. Suitable poles are 1" to 3" in diameter and should be cut into 4' to 10' lengths. Make clean cuts and avoid splitting ends. Large anvil style loppers work best for making these cuts. If the loppers can't cut the branch, then it is too big to be a stake or pole. The butt ends of the stakes and poles need to be trimmed to a 45-degree angle and the tops need to be cut flat. This allows for easy identification of which end goes in the ground during planting. If you are unsure which end is up, look at the leaf bud scars. They always point up.Trim all lateral stems from the stakes and poles as flush as possible.

Storage:
The key to successful live staking and pole planting is keeping the stakes and poles wet. You will get the best results if you soak the cuttings in water for about a week. At a minimum soak cuttings for 24 hours. Tie stakes or poles together into bundles that are easy to manage. Completely submerge the bundles in any body of water. If you do not have access to a body of water you can soak the bundles in a large garbage can filled with water or cover the bundles with burlap and keep them wet using a sprinkler. The sooner you get the cuttings in the water the better.

Planting:
Stakes - Create a pilot hole using a small sledge hammer to drive a 3' - 4' concrete stake into the ground. You may have to hit the side of the stake to loosen up the soil so you can remove the stake. Insert the butt end of the live stake (with 45-degree cut) into the pilot hole using the dead blow hammer if necessary to pound in the stake. Insert the stake so that 80% of its length is below the ground. Trim the top if it becomes smashed or split during planting. Tamp the soil around the stake and water heavily soon after planting. Plant stakes every 1 - 3 feet.

Poles - Use a backhoe with a "Stinger" or an auger to create a planting hole that reaches into the water table. Insert the butt end of the stake (with 45-degree cut) into the planting hole. Insert 1 - 2 poles so that 80% of the pole is below the ground. Trim the top if more than 1 foot remains above ground. Tamp the soil around the stake and water heavily soon after planting so as to eliminate air pockets in the soil around the pole. Plant poles every 1 - 3 feet.

Photo courtesy of Salix Applied Earthcare

Willow Wattles

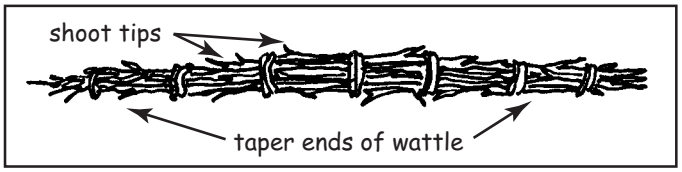
Vance Howard, Yolo County RCD

Description and Benefits of Willow Wattles

Willow wattles are long cylindrical bundles of live cuttings that can be used for both streambank protection and to reduce erosion, aid drainage, and improve infiltration on dry upland slopes. Willow wattles are similar to fascines (see *Live Fascines and Live Pole Drains*), with the exception that for wattles the cuttings are arranged in alternating directions throughout the length of the wattle. Wattles are typically installed in combination with other streambank protection practices (e.g. brush mattresses, live siltation, reinforced brush layering), but they also have useful application as a stand alone practice. In streamside situations, wattles placed at the toe of the streambank can help protect against the stream cutting into the bank as well as capture sediment that sloughs from the upper bank. Wattles can also be installed in shallow staggered trenches on upland slopes. The trenches are dug on contour. The staggered series of wattles breaks the slope length into several short slopes. This regulates the energy of the runoff flowing down the surface of the slope providing for improved infiltration and reduced erosion. As the cuttings in the wattles become established, they serve to further stabilize the slope and provide habitat for wildlife.

Conditions Where Willow Wattles Apply

Willow wattles are well suited for streamside use as well as on upland slopes. Wattles are used in streamside situations where immediate as well as long-term stabilization is needed. Wattles can be installed at the toe of the streambank (similar to coir rolls), but will require sustained flows through the dry season to ensure establishment. Wattles are often used as toe protection in combination with other practices. They can also be installed in several rows up an eroding slope or high streambank in cases where the rills are forming on the slope or sloughing is occurring due to the affects of overland flow.



Materials Needed

- Handtools: shovels, rakes, anvil loppers, hand pruners, fence wire tool, sledge hammer.
- Live cuttings (stakes and poles): use native plant material that is most appropriate to the site as well as abundant near the site (Willow, Cottonwood, Mulefat, Coyotebrush, other easily rooted species).
- Water source for soaking live cuttings: pond, troughs, stream, burlap and sprinklers.
- Wooden stakes: 2 to 4 feet long with a notch for securing wire approximately 3 inches from the top.
- Wire or rope: medium gauge fencing wire or polypropylene rope for securing the live fascines and pole drains.
- Native grass seed and mulch.

References

McCullah, J.A. 2000. *BioDraw 1.0 CD-ROM*. Salix Applied Earthcare.

Schiechtl, H.M. and R. Stern, 1997. *Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection*. English Translation with additions. Blackwell Science, Ltd.

United States Department of Agriculture, Natural Resource Conservation Service (USDA-NRCS). 1998. *The Practical Streambank Bioengineering Guide*.

United States Department of Agriculture, Natural Resource Conservation Service (USDA-NRCS). 1992. Soil Bioengineering for upland slope protection and erosion protection. *In National Engineering Handbook (NEH)*, Part 650, Chapter 18.

Willow Wattles

Implementation

Willow wattle construction:

- First harvest the cuttings according to the guidelines for Pole Planting and soak the cuttings for at least 24 hours. Willow can be used for most applications, even on dry upland slopes. Other locally available material may also be used provided that it will root from cuttings.
- Tie together the live cuttings into bundles of 10 to 30 feet in length and 6 to 16 inches in diameter. Be sure that the cuttings alternate in orientation and that the tips of the cuttings are staggered throughout the length of the wattle. Tie the wattle together with twine every 2 feet. Taper the ends of the wattle in case it will be joined to another one during installation.

Installation:

- Perform any slope repairs or regrading prior to wattle installation.
- Dig a shallow trench on the contour at the mean low water level (i.e. summer flows) at the toe of the streambank along the length of the site. The trench should be as wide as the wattle and half as deep. If the streambank has a long slope with a sloughing vertical bank at the top, a second or third wattle can be installed at intervals up the slope.
- Lay the wattle in the trench along the length of the site. If more than one wattle is needed, be sure to tie together the ends of the adjoining wattles with rope. Also be sure that a stake is aligned at the joint.
- Drive a wooden stake every 2 to 3 feet into the center of the fascine. Additionally drive live stakes on the downslope side of the fascine in the intervals between the wooden stakes. In some cases (particularly at joints) you may need to drive parallel wooden stakes upslope and downslope of the fascine and secure the fascine to the ground with a wire that runs between the two wooden stakes.
- Tie wire or rope between the parallel wooden stakes at the notch and pound into the ground until the wattle is held secure. If the ground is too rocky for wooden stakes, use rebar or metal concrete form stakes instead.
- Backfill the area behind the wattle forming a small bench.
- Dig a trench approximately 2 feet wide by 2 feet deep perpendicular to the contour, from the mean low water level to above the mean high water level at the upstream and downstream ends of the wattle (this is a trench that is running up and down the slope).
- Install rock riprap or rootwads into the trench. The purpose is to keep the stream from cutting behind the wattle. If installing rock riprap or rootwads is not feasible, dig the trench half as deep and install an additional wattle.

For dry upland slope situations, follow the guidelines for live fascines, except install the wattles on contour (not at an angle). For dry slopes the goal is to improve infiltration of runoff into the soil, not direct the runoff off the slope as is the case with live fascines and pole drains.